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JANUARY, 1956 Vol. 46, No. 5

The Macmillan Company
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Oldenburger's

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Edited by* RUFUS OLDENBURGER, *Director of Research, The Woodward Governor Company, Rockford, Illinois

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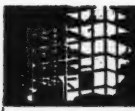

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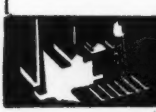

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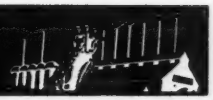

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DO YOU KNOW . . . .

► . . . . That at its meeting in November the Executive Board and Council of the Society approved a budget of $26,100 for the study of atomic energy education as proposed by the Atomic Energy Education Committee headed by P. N. Powers of the Internuclear Company? This will be a comprehensive study, similar to that for *The Evaluation of Engineering Education.* The areas to be studied are present and future requirements for men in nuclear fields; undergraduate, graduate, and special programs for training engineers; the part of colleges and universities; the long-term role of training in Government Laboratories. Chairman of the study group is Dean G. A. Hawkins of Purdue University. The Atomic Energy Education Committee has been working very closely with the Atomic Energy Commission of the Federal Government, and since there is now some evidence that the Government Laboratories may decrease their educational programs as time goes on, the need for this study is very great. It is expected that two years will be required for completion. Funds are being sought from industries interested in engineers with training in nuclear specialties.

► . . . . That you should keep your eyes open for the final report of the Humanistic-Social Research Project? It should be received from the printer next month and copies can be obtained from this office for 25¢ each, 20¢ each in lots of 50 to 100, and 15¢ each in lots over 100. After acceptance by the General Council of ASEE, the report will be published in the JOURNAL.

The ASEE General Council will be asked to approve the report at its June 25 meeting. It is then proposed to ask approval for the spending of remaining funds to pay expenses of active committee members who are invited to speak at Section and other meetings where the findings of the report can be more fully discussed and publicized. Section officers and program chairmen—take a hint!

► . . . . That progress is being made in the Armed Services' handling of technical manpower? The material in the paragraphs below was prepared by President M. M. Boring for the President's News Letter, sent out in October, but it is important enough to repeat here as information we all should have.

"The Reserve Bill passed by the Congress and signed by the President became law in August, 1955. Included in this law is a provision for up to 250,000 young men 18½ years of age and below, and a group of young men 18½ years and beyond who have critical skills and who are in short supply to be permited to enlist in an active Reserve unit for a period of 7½ years, the initial enlistment to include six months of active duty.

"The Bill also provides for the screening from the Active Reserve to the Standby Reserve those individuals who can demonstrate that their skills in a civilian capacity override the military skills they have acquired, providing the number so classified is in excess of the military requirements for that particular skill.

"The criteria for the identification of those individuals with these critical skills and the criteria for their being screened from the Ready to the Standby Reserve are 'in the mill' in Washington.

"Many discussions have been held in connection with the development of these criteria, and it is apparent that the final outcome will be satisfactory. Our engineering students will then find themselves much better able to identify their responsibilities both in the timing and length of service period.

"As Chairman of the Engineering Manpower Commission and a member of the Committee on Specialized Personnel, I will constantly keep in touch with this pending action, and as soon as definitions are complete and established I will provide information to all of the engineering schools."

► . . . . That suggestions are available for the many of you who are now preparing programs for the Annual Meeting or are thinking about a talk or report to be presented? Everyone on the program should "speak to the audience" this year and not "read a manuscript." What is required for good oral presentation is not necessarily the same as what is required for a manuscript to be printed, nor is an acceptable manuscript a faded copy of the oral version. *Program chairmen* see that every speaker makes his dual preparation—a vigorous oral presentation to make the audience sit up and take notice, and a potent, compactly written manuscript for publication in the JOURNAL. Every Division should have good papers to submit. The English and Social-Humanistic Divisions are being asked to clarify some of the differences between oral and written work. We hope that these comments, in expanded form, will become available in the near future as articles or style sheets.

► . . . . That in developing the program for its third meeting, the Executive Committee for the EUSEC Conference on Engineering Education and Training assigned the topic "Criteria for Professional Recognition" to the United States of America? Dean Thorndike Saville of New York University is serving as chairman of the U. S. delegation and in behalf of the EUSEC Societies of the United States has had a questionnaire prepared and mailed out to all participating societies of the engineering societies of Western Europe and the United States. ("EUSEC" means European-United States Engineering Education Conferences.) The four pages of questions deal with such current problems as the definition of a professional engineer, legal requirements for professional practice of engineering by an individual, legal requirements for professional practice of engineering by a corporation, criteria for professional recognition other than legal, and titles of recognition. Attached to the questionnaire is the following definition of "Professional Engineer."

"A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the solution of problems, and to assume personal responsibility for the development and application of engineering science and techniques especially in research, designing, manufacturing, superintending and managing. His work is predominantly intellectual and varied, and not of a routine mental or physical character, but requires the exercise of original thought and, if necessary, the responsibility for supervising the technical and administrative work of others.

"His education will have been such as to make him capable of closely and continuously following all progress in his

branch of engineering science by consulting newly published work on a world-wide basis, assimilating this information and applying it independently. He must be able to make contributions to the development of engineering science and its application.

"By virtue of his education and training he will have acquired a broad and general appreciation of the engineering sciences as well as a thorough insight into the special features of his own branch, with the result that in due time he can give authoritative technical advice, or be responsible for the direction of important tasks in his branch."

► . . . . That you should be sure to read the Statement of Policy this month, in which the Editor presents a few ideas about the JOURNAL and JOURNAL articles!

W. LEIGHTON COLLINS
Secretary

WALKER NAMED VICE-PRESIDENT OF PENNSYLVANIA STATE UNIVERSITY

Dr. Eric A. Walker, Dean of the College of Engineering and Architecture at the Pennsylvania State University, has been named vice-president of the University, effective June 30, 1956. In announcing the appointment, President Milton S. Eisenhower explained that Dean Walker will coordinate and stimulate the research program. Appointed Dean of the College of Engineering and Architecture in 1951 to succeed the late Dean Harry P. Hammond, Dr. Walker came to Penn State in 1945.

From 1942 to 1945, Dean Walker rose from research associate to associate director of the Harvard Underwater Sound Laboratory at Cambridge, Massachusetts. For his work there, he was awarded the Naval Ordnance Development Award and also a Presidential Certificate of Merit. From 1945 to 1951, the vice-president designate served in a dual role as director of the Ordnance Research Laboratory and as professor and head of the Department of Electrical Engineering.

As Dean of the College of Engineering and Architecture, Dr. Walker has greatly expanded the work of the College to include the construction of the Research Reactor, the computation center in the department of electrical engineering, and the development of the program in engineering science.

Born in Long Eaton, England, Dr. Walker received his bachelor, master, and doctor of science degrees at Harvard University. He has served as a vice-president of the American Society for Engineering Education and as a director of the Engineering College Research Council. He is a member of the American Institute of Electrical Engineers, the American Physical Society, a fellow of the Acoustical Society of America, a member of Tau Beta Pi, engineering honor society, and is a registered professional engineer in Pennsylvania and Connecticut.

IOWA STATE COLLEGE HOST FOR ASEE ANNUAL MEETING

The sixty-fourth annual meeting of ASEE, June 25–29, 1956, will enjoy the hospitality of the Engineering Division, Iowa State College, at Ames, Iowa. A pleasant town with a population of 15,000 (excluding students), Ames is located near the center of the state, some 35 miles north of the capital city of Des Moines, and is easily reached by auto, rail, or plane. East-west transcontinental highway U. S. 30 and north-south U. S. highway 69 join there. The main line of the Chicago and Northwestern Railroad passes through Ames, and transcontinental planes stop at Des Moines, an easy bus trip away.

An active group of local committees, headed by Professor L. O. Stewart and G. R. Henninger, have been planning arrangements, and promise a warm welcome with accommodations equal to any. Ample housing will be available on campus as well as in Ames, and an extensive schedule of entertainment is being projected.

Background

Iowa State, now enrolling more than 9000 students, was one of the first of the land-grant colleges. Its establishment was begun late in 1862, though the first students were not admitted until 1868. The first curricula were, of course, agriculture and "mechanic arts," the latter soon broadening into engineering. Until 1870, the essentials of mechanical and civil engineering "arts" were taught, plus courses in social science, philosophy, and the cultural studies allowed by the land-grant act.

By 1873 a specific curriculum in mechanical engineering had been established; civil engineering became a separate department in 1876, and both mining engineering and architecture were listed as separate studies in the catalogue of 1877. The Bachelor of Science degree was awarded in Engineering until 1878, when the Bachelor of Civil Engineering and Bachelor of Mechanical Engineering were conferred, with advanced degrees of Civil Engineer and Mechanical Engineer. (Through 1955, a total of more than 12,000 degrees in engineering had been granted to graduates who have served the profession with distinction in all parts of the world.)

The Division of Engineering was organized as such about 1896, with four departments. The largest of five major divisions in the College as a whole (the others being Agriculture, Home Economics, Science, and Veterinary Medicine), Engineering now enrolls more than 3000 students in eleven departments and curricula. These include aeronautical engineering, ceramic engineering, chemical engineering, agricultural engineering, architecture and architectural engineering, civil engineering, electrical engineering, industrial engineering, and mechanical engineering. Graduate courses, given in each of the curricula named and in nuclear engineering and theoretical and applied mechanics, lead to advanced degrees.

These several departments are supplemented by an Engineering Experiment Station, among the earliest organized in the nation, an Engineering Extension Service, and the Ames

Laboratory of the Institute for Atomic Research.

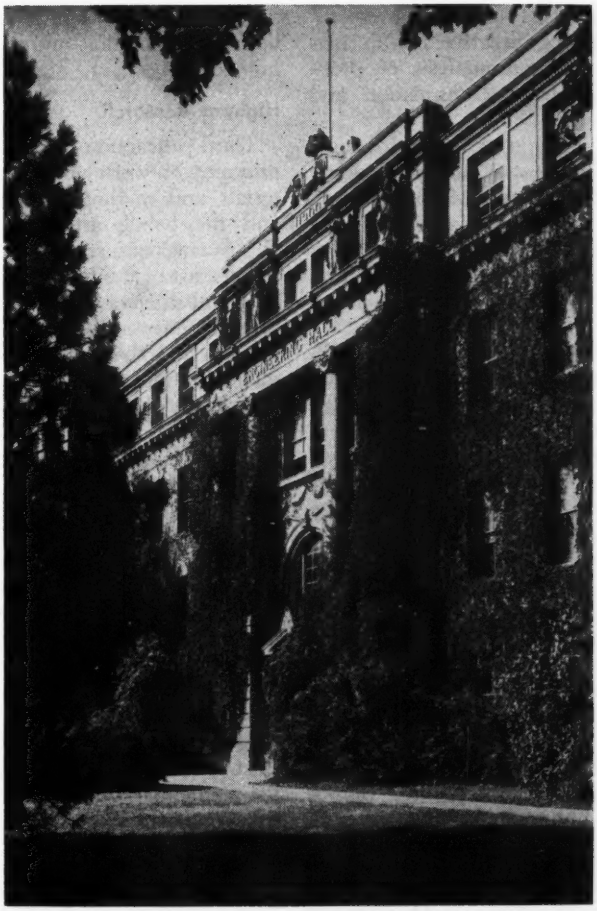
Iowa State College is continuing to expand under its tenth President, Dr. James H. Hilton, as is the Division under its third Dean, J. F. Downie Smith. (Dean Anson Marston was first in succession for Engineering, from 1904 to 1932, with Thomas R. Agg as the second from 1932 until 1947, when Dean Smith was appointed.)

On the spacious and beautiful campus created from what was originally open prairie, with a site located only by survey lines, the Division of Engineering now occupies more than ten major structures. Headquarters are in Marston Hall, the main engineering building. Other activities are housed in the Engineering Annex, the Electrical Engineering Building, and in separate structures for Agricultural Engineering, Mechanical, Aeronautical, two buildings for Chemical Engineering, and an Experiment Station. These are supplemented by a group of auxiliaries serving all the departments and the Experiment Station.

Activities of Interest

In addition to the instructional laboratories, all of which will be on display for the ASEE, several extensive facilities will demand inspection. Ames is a center of nuclear science, an important aspect of the 1956 ASEE program. The Ames Laboratory of the United States Atomic Energy Commission played an important part during World War II. Facilities of the Institute for Atomic Research and the Ames Laboratory include buildings for offices, general

Electrical Engineering Building, Iowa State College, Ames, Iowa



Marston Hall, Headquarters for Division of Engineering, Iowa State College

work areas, for research, metallurgy, and the Synchrotron—all built since World War II. (A related feature of the Annual Meeting will be the banquet address by U. S. Senator Bourke B. Hickenlooper, of the Joint Congressional Committee on Atomic Energy.)

A second outstanding point of interest will be the Engineering Experiment Station. Active work is being carried out on more than thirty extensive research projects, as well as many minor investigations. Activities are included for all the primary engineering fields. Examples of larger projects are those on the utilization of agricultural by-products, manufacture of fertilizers, extraction of vegetable oils, development of highway

materials and construction methods, soil mechanics, creativeness in machine design, and analysis of problems in electrical transmission and distribution.

The publication of research results has always been an important activity of the Station. More than 175 bulletins have been issued, and numerous papers have been prepared for presentation to engineering societies.

WOI-TV

A visit to the studios of WOI-TV, the first educational television station to be opened for operation, and the 100th station to begin telecasting in the United States, is a must for all ASEE visitors concerned with the audio-visual arts. WOI-TV is also unusual in being an educational station which carries commercial programs for profit. It utilizes Channel 5, with a power of 500,000 watts, from a transmitter tower 580 feet high, to cover an audience radius of 100 miles for more than sixteen hours per day.

Established in February, 1950, WOI-TV is a modern extension of the traditional land-grant college concept of service to the public. Its operations emphasize teaching, program development, and student experience both in production and in engineering capacities.

Highway Research

Third attraction is the extensive program of work with highway materials and methods of construction, and the headquarters of the State Highway Commission in Ames, about a mile east of the Iowa State Campus. Although there is no direct organizational connection between the Commission and the College, the Experiment Station carries on broad research under the sponsorship of the Commission.

In short, as the map will show, all roads lead to Ames for Engineering Educators in 1956. There will be a rich program, old friends, and much of technical and agricultural interest to see. Also, for those vacation-bound after the meeting, Ames is an excellent jumping-off point in any direction. Easterners will find Iowa well on their way to the West, or to the north woods and lakes; for the West, Ames opens both the South and East. Be sure to put June 25–29 on your calendar, and enjoy true mid-western hospitality!

Iowa State College Committee for the Annual Meeting

General Chairman . . . L. O. STEWART Vice Chairman . . . . G. R. HENNINGER

Committee Chairmen

Auxiliary Services . . . L. R. HILLYARD
Banquets and Luncheons
E. W. ANDERSON
Conferences and Sessions
G. R. TOWN
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Finance . . . . . MORTON SMUTZ
Housing and Registration
M. E. GOULD
Ladies Program . . MRS. H. M. BLACK
Printing . . . . . H. J. STOEVER
Publicity and Information
J. H. BOLTON
Transportation . . . . . L. H. CSANYI
Trips and Entertainment
L. S. LINDEROTH
Young Peoples Program
MRS. J. F. SANDFORT

CAN 500,000 ENGINEERS BE PROFESSIONAL?

ERIC A. WALKER

Dean, College of Engineering and Architecture
Vice-President-Elect, The Pennsylvania State University
University Park, Pennsylvania

In the early 1930's, Matthew Woll, vice-president of the American Federation of Labor, is supposed to have told a group of engineers, "The trouble with you fellows is that you fancy yourselves as professional men; actually, you are just hired help." The statement is true, whether it was actually made or not. Engineers do like to believe they are members of a *bona-fide* profession, yet most of them are salaried employees. The real question is not the truth of the statement, but the truth of the assumptions on which it is based. Does the fact that engineers are "hired help" bar them from the ranks of professional men? Are unionization and professionalism incompatible? And how sound is the engineers' claim to professional status?

For all practical purposes, the engineers' interest in professionalism has been linked with the question of unionization for just about twenty years. When the Labor Relations Act was passed in 1935, many engineers were included in bargaining units along with technicians, factory workers, artisans, and other "subprofessionals." This grouping was perhaps a natural one. Engineers have by tradition worked closely with these groups, and it is these groups that have worked hardest for unionization. By focusing attention on the engineer's ambiguous position, however, the new law aroused his interest in professionalism and raised a question that has not yet been satisfactorily answered.

Grasping for straws, the officials finally ruled in this case that engineers, as salaried employees, were not eligible for union representation, which was, or should be, restricted to hourly wage workers. This ruling did not help much, and in 1944 the National Labor Relations Board attempted a more careful job of definition. "Professional engineers," NLRB declared, "do essentially creative work." The definition went on to point out that engineers write the directions for others to carry out, much as the doctor writes the prescription that is compounded by the pharmacist and administered by the nurse or patient. This fact, NLRB declared, eliminated the engineers from nonprofessional ranks.

Once the question had been raised, however, it was not to be settled easily. Consequently, the Taft-Hartley Act attempted to spell out the requirements for professionalism in terms of both the man and his work. "The term professional employee," it ruled, "means

A. Any employee engaged in work (1) predominantly intellectual and varied in character, as opposed to routine mental, manual, mechanical, or physical work; (2) involving consistent exercise

of discretion and judgment in its performance;
(3) of such a character that the output produced or the result accomplished cannot be standardized in relation to a given period of time;
(4) requiring knowledge of an advanced type in a field of science or learning customarily acquired by a prolonged course of specialized intellectual instruction and study in an institution of higher learning or a hospital, as distinguished from a general academic education or from an apprenticeship or from training in the performance of routine mental, manual, or physical processes; or

B. Any employee who
(1) has accomplished the course of specialized intellectual instruction and study described in clause 4 of paragraph A; and
(2) is performing related work under the supervision of a professional person to qualify himself to become a professional employee as defined in paragraph A."

Perhaps these rulings and interpretations formed an adequate basis for administering the law. They failed, however, to satisfy the engineer. Perhaps they kept the door to professionalism from being slammed in his face; but they failed to convince him —or the public—that he is, in fact, a member of a profession. Engineers have been trained too long and too well to forge their opinions in the crucible of stubborn and irreducible facts to draw a conclusion so easily, even a desirable one.

What, actually, is the professional status of the engineer? Is he already under the sun but fails to realize it because his eyes have not yet adjusted to the new light? Or is he still groping to find the door left open by the legal interpretations?

"Professionalism" is not an easy word to define. The learned professions, according to Noah Webster, are the law, the ministry, and the healing arts. However, not all doctors, for instance, qualify, just as not all officers of the Armed Forces qualify as gentlemen, despite the Act of Congress conferring the title on them. On the other hand, public acceptance often confers professional status on individual members of groups outside the traditional three. Almost every community, for example, has a landscape artist who is a "real professional."

Actually, as these examples show, professionalism is a double-barreled sort of thing. In part, it is *obtained* by satisfying certain established conditions, such as those spelled out in broad outline by the provisions of the Taft-Hartley Act. But in part it is *conferred* by the community at large on an individual or group because of the acceptance by that individual or group of a code of ethics—a code that the individual or group refuses to compromise for personal gain or prestige. None of the legal interpretations mentions this aspect of professionalism.

Thus, the officer is a gentleman (1) because he has satisfactorily completed all the rigorous requirements for a commission in one of the branches of the Military and (2) because his personal conduct is recognized as being exemplary. The officer who fails to qualify on the second ground is the true author of the derisive phrase "officer and gentleman—

by Act of Congress." The medical doctor, by virtue of his title alone, is a professional man on the first ground; the landscape artist qualifies only on the second.

What are the tangible requirements for professionalism? And how do the engineers stack up as a group with the traditional professions in these requirements?

Let's use the medical doctor for comparison. Before he is allowed to offer his services to the public, he must have received a degree from a university, taken three to five years of postgraduate work, served an apprenticeship, and passed a rigorous examination. That's all there is to it, except for the fact that the curriculum, apprenticeship, and examination are so tough that he must have higher-than-average intelligence, ability, and perseverance to arrive finally at his own practice.

Here the engineers stack up rather well. Undeniably, it requires an intelligence higher than average to complete today's engineering curricula. At The Pennsylvania State University, for instance, only one out of every three freshmen who enter the College of Engineering and Architecture lasts long enough to be finally handed his parchment replica of the traditional sheepskin. In addition, studies have shown that the undergraduate with an I. Q. of less than 120 has little chance of securing his B.S. degree in engineering.

It can also be shown that an engineering career demands long hours of postgraduate work at a university, in company courses, or through self-study. Many industries today offer training courses and curricula equivalent in every respect to those offered at the graduate level in academic institutions.

It is true that comparative training for engineering is not quite as long as that required for either the lawyer or the medical doctor, each of whom must obtain a bachelor's degree before attending his specialized school. The engineers, however, have followed the doctors and lawyers in establishing public licensing laws. In most states, this license is granted only after the completion of an apprenticeship under the direction of a licensed engineer. This takes care of the M.D.'s internship. In all states, the engineer must pass a rigid examination before the title "professional engineer" is granted him.

This title indicates the engineer has essentially met all the tangible requirements for professionalism. How does he measure up by the intangible standards?

It is difficult to analyze what causes a person or group to be accepted as being professional by the public. It is clear, however, that this acceptance is not based on objective or legal standards. The title does not *per se* confer professional status. It indicates a professional *competence;* it does not yet indicate a professional *morality.*

Let's look again at the doctor. Traditionally, doctors selflessly devote their lives to the public welfare. The popular belief is that, as a group, they are dedicated to the service of humanity, just as are ministers. All studies show that doctors have the highest annual income of all classes of "workers." The public seldom thinks of this; it thinks, rather, of the early morning calls to take care of Johnny's stomach ache, made despite the fact that Johnny's father is out of

work and cannot pay for the call. The demand for doctors today is tremendous, and any graduate M.D. is guaranteed a lucrative practice. When Johnny decides to enter medical school, people speak admiringly of his sacrifice and dedication, of the long years he must spend in training, not of his prospective income.

All this adds up to an attitude: an attitude, or a set of attitudes, defining the moral responsibilities of the man to his job and the outlook of the public toward the man as a member of a group. As an attitude, it cannot be legislated, any more than prejudice can be eliminated by Federal decree or the attitude of the people toward drinking could be changed by a Constitutional amendment. It cannot be conferred or denied because of the grade on an examination. It has nothing to do with the amount of training required to do the job. It takes no account whatever of whether the man is a hired hand or an independent practitioner, or whether he works in his private quarters or in a big office with hundreds of others.

Francis Bacon wrote, "I hold every man a debtor to his profession." A more modern writer put it this way. "Professional status is granted by the public through recognition, identification, and respect for learning and service of the individuals in the professional category."

In other words, the professional man is one whose reputation for competence and integrity is such that uninformed laymen can, and do, entrust their lives, their health, and their property to him. To win this reputation, he must first of all approach his calling as a position of public trust. It is a question of the assumption of public responsibility.

The doctors do not leave the inculcation of this attitude, or code of behavior, to chance. Even during his premedical training, the embryonic M.D. begins to receive instruction about his responsibilities and duties to his fellow men. This training culminates in the administration of the Hippocratic Oath, with its emphasis on self-sacrifice, upon his graduation from medical school. Machinery is even set up to enforce its observance by punishing those who, through weakness or selfishness, fail to adhere to it.

It is this standard of behavior, this code of ethics, that makes it difficult to rationalize professionalism and unionization. Unionization concentrates on the relationship between the employee and his boss. Professionalism centers on the relationship between the man and his work.

The major purpose of a union is to improve the lot of the employee by securing for him increased wages, improved working conditions, and the fringe benefits he desires. This is an essentially selfish goal. It puts "my" good first, above the good of my fellow men, if need be. It results, for instance, in higher wages for coal miners, even though the method of obtaining this increase cuts off the nation's coal supply in the middle of December.

The professional man's task calls for discretion and judgment and requires him to produce the best possible answer in any particular situation. The best possible answer for whom? First, for humanity; second, for his employer; third, if there is a third, for himself.

There is little pressure for the average factory worker to worry about humanity. His daily activity, except

in isolated instances of mercy and the like, little affects the public welfare. On the other hand, it is absolutely necessary for the doctor to be concerned with humanity at large, since almost every decision he makes involves the general well-being of the community.

But isn't this true also of the engineer? He designs our roads and the automobiles that travel on them. He designs the buildings, the factories, sometimes the cities in which we work and play. He designs the equipment that frees man from undignified and life-shortening labor, from the simple vacuum cleaner to the giant computers that perform in seconds calculations that would require scores of mathematicians years to complete. He designs the weapons that permit us to maintain our ability to protect our way of life effectively and to prevent the enemy from devastating our land with an annihilative war. No one, not even the doctor, is more responsible for the health and welfare of our country than is the engineer.

To be accepted as truly professional, then, the engineer must meet this challenge. He must make it clear that he recognizes his duty to humanity and is prepared to accept it. It must be obvious that his decisions are aimed first at the good of the community. His own selfish interests must be clearly subordinated. "Where there is love of man," Hippocrates wrote, "there is love of art."

It is here that the engineer is at the crossroads. One branch leads to professionalism, the other to craftsmanship. Not all engineers, however, are convinced that the road to professionalism is the right one to take. Of the half million engineers with some claim to professionalism, almost 40,000 are presumably sufficiently dissatisfied with their present status to join engineering unions in the hope of improving their lot.

There are ever-increasing signs, however, that more and more engineers are recognizing their corporate duty to mankind and are prepared to accept the discipline it demands. For instance, the American Society for Engineering Education, which pioneered the inclusion of socio-humanistic studies in the engineering curricula, established in 1952 a committee to study the problem of ethics in engineering. Interest in the work of this committee has been so high that the committee has had little time to do anything but answer its correspondence. Although the engineers have nothing sufficiently traditional to compare with the Hippocratic Oath, a limited survey by the ASEE committee revealed that 70 per cent of the 87 colleges of engineering polled gave some sort of instruction in ethics to the engineering undergraduates. In another instance, the more than 33,000 members of the National Society of Professional Engineers voluntarily accepted in 1954 a creed that reads, in part,

> "As a professional engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare. I pledge . . . to place service before profit, the honor and standing of the profession before advantage, and the public welfare above all other considerations."

In actual performance, the engineers have demonstrated this awakened consciousness of public duty. Seldom do you hear of an engineer performing a technological abortion, as those who make decisions based

upon recommendations of engineers often seem to do. Even the severest critics admit that when the chips are down (as they were in World War II) the "engineering achievement was indeed phenomenal." "The 'guild of engineers,'" one critic grudgingly admitted, "eagerly knuckled down to meet the quotas. . . ." Engineering decisions are not always popular, but they are remarkably honest. Surely this is the beginning of a professional morality.

If the engineers accept this tremendous discipline for selfless service to the public welfare—if they accept the responsibility of directing their rather frightening potential for harnessing the forces of nature for the good of mankind—the public will not long delay the conferring of professional status. And all signs indicate that most engineers, both as individuals and as members of a group, have already stepped out firmly in the direction of professionalism.

KEREKES TO BE PRESIDENT OF AMERICAN CONCRETE INSTITUTE

Frank Kerekes, Dean of the Faculty, Michigan College of Mining and Technology, Houghton, and member of ASEE since 1927, has been nominated as President of the American Concrete Institute to succeed Charles S. Whitney for a one-year term beginning at the February, 1956, convention.

Dean Kerekes has been a member of ACI since 1938. He is chairman of Committee 318, Standard Building Code, and a member of Committee 315, Detailing Reinforced Concrete Structures. He has been serving as vice-president since 1954 and has served on the Technical Activities Committee, 1948–50, and the Board of Direction, 1951–54.

Dean Kerekes received his BS degree from City College of New York and the degree of Civil Engineer from Columbia University. He immediately joined the civil engineering faculty at Iowa State College, Ames, where he served for 34 years and advanced to be assistant dean of engineering. While at Iowa State he also served as chairman of both the Ames City Plan Commission and the Iowa Building Code Council. Kerekes is Past President and Honorary Member of the Iowa Engineering Society, which presented him with the Anson Marston and John Dunlap Medals. He is a member of the Michigan Engineering Society.

He is the author of text books and articles on education and civil engineering and has served as consulting structural engineer for architectural firms and industrial organizations. He is active in professional and civic circles.

THE ENGLISH PROGRAM AS ENGINEERING TEACHERS VIEW IT

FRANK KEREKES

Dean of the Faculty
The Michigan College of Mining and Technology
Member, General Council, ASEE

Presented at the English Division Conference, the ASEE Annual Meeting, Pennsylvania State University June 21, 1955

A civil engineer practicing in structural analysis and design, Dean Kerekes had his first opportunity to learn English after he was seven years old. He has for more than thirty years been closely associated with the teaching of a required course in report preparation, and for more than ten years was chairman of a College-wide Committee on Student English. These experiences are the setting for his "intense conviction that power in the use of English is the essential skill in all professions."

We are at the point where many are urging a critical and comprehensive review of the content, function, and method of teaching English in the freshman year of engineering curricula. Furthermore, there has been so much of value written and said about the apparent shortcomings of prevailing English programs that implementation and action rather than continued surveys and deliberations are the urgent need.

The teachers of English and of the other subjects in the college curricula should combine and cooperate in their program for developing effective means of communication among college and university students. To accomplish this objective each should be conscious of and sympathetic with the problems of the other. An eminent mining engineer, a generous public servant, Past President of the United States of America, and a venerable citizen of the world, Herbert Hoover, epitomizes the engineering profession thus:

"I cannot leave my profession without some general comment upon it. Within my life time it has been transformed from a TRADE into a PROFESSION. It was the American universities that took engineering away from rule-of-thumb surveyors, mechanics and Cornish foremen and lifted it into the realm of wider learning in the humanities with the higher ethics of a profession ranking with law, medicine, and the clergy. And our American profession has brought a transformation in another direction through the inclusion of administrative work as a part of the engineer's job. "

With the prestige of a profession, the engineer assumes added responsibilities, not the least of which is to communicate his ideas to his fellow engineers and to the citizens of his community, be they in his home town, his state, his country or the world at large. Charles Kettering of General Motors has said that "a man's language is an index of his mind." The mind of the truly professional engineer is trained in several rigorous disciplines of expression: linguistic,

graphical, mathematical, and, to a limited extent, aesthetic. As Harry S. Rogers, Past President of ASEE, puts it:

"Because of competitive demands for time in such training, writing upon engineering matters has frequently failed to receive the attention necessary to develop any degree of proficiency, and courses in composition have lacked the motivation which could have been made available by compilation of stirring, challenging, and interesting informative writing."

Fortunately this is an opportune time not only to evaluate existing English programs but also to develop new ones. There is a growing recognition among scientists, engineers and educators that the faculties of departments of English have important new contributions to make. By the very nature of their training, experience, and interest they can serve the broad function of developing among freshman engineering students the humanistic-social consciousness. They can perform this function and at the same time strengthen their influence in the application of the principles which govern the use of language in writing, speaking, reading, and understanding. The ASEE Committee on the Evaluation of Engineering Education made its final report in June, 1955. As a result of the findings of this report many schools of engineering will be giving serious attention to curricula revisions. Certainly, no more effective time could present itself for the introduction of a new, vital, and vigorous English program.

What Do We Have to Offer?

Broadly reviewed, the contents, objectives, and emphases of freshman English courses available to engineering students are in too many instances patterned after programs which could logically celebrate their fiftieth if not their one-hundredth anniversaries. Formal engineering education in the United States of America is hardly more than 125 years old. In that time there has been a tremendous extension in the science and practice of engineering, not to mention the transition from a largely empirical approach to a highly abstract, mathematical, technological and industrial treatment. Yet, with a few noteworthy exceptions, English programs for engineers are gripped by precedent rather than liberated by the challenge of evident, realistic, and creative possibilities for improvement.

What do we have to offer today? Let us go to the college catalogues to provide the answer, which could be summarized as follows:

English A–B–C. Three credits per term throughout the freshman year.

"Frequent short papers. The fundamentals of expository writing; outlining, paragraphing, sentence structure, mechanics. Study of formal grammar. Study of expository prose. An approach to judicious reading. Careful analysis of both good and bad writing. Materials for writing to be drawn from readings in imaginative literature."

In contrast to the foregoing (which is the usual pattern), there are all too few indications of an effort to make English more vital, stimulating, and challenging.

English X–Y–Z. Three credits per term throughout the freshman year.

"This course is designed to help students think, speak, write, and understand the living English of the United States of America.

"Emphasis is placed upon skill in using clear, forceful, accurate, and idiomatic language for expression of ideas, and

upon skill in intelligent, critical, and discriminative reception of ideas.

"The skills involved in reading, writing, speaking and listening are combined in a single course (throughout the year), because intelligent use of language is equally essential to all of them.

"As clarification of meaning is a prerequisite of all learning, the ability to clarify and to communicate ideas efficiently and effectively is the aim of this course."

The first catalog description, English A–B–C, typical of the English program offered to most freshman year engineering students and presumably to all freshman students in most colleges, appears to be based upon the premise that high school English does not "TAKE," so the college department of English must use the energy, time, and effort of mature and able English teachers to inculcate English disciplines which should have been acquired in high school. Furthermore, in most institutions, little if any attempt is made to differentiate between the well prepared and poorly prepared high school graduate insofar as the credit they receive for high school English or the challenges presented in their college English requirements are concerned.

The second catalogue description, English X–Y–Z, is the exceptional English Program available to Freshman Year engineering students. One must admit, however, that, not having the course outlines at hand, one cannot know how much difference there may be in the actual course content and method of teaching between typical courses English A–B–C, and unusual courses English X–Y–Z.

Does Freshman English "TAKE"?

Judging from the continuous and persistent assertions made by teachers and employers of engineering students, one may conclude that the answer to this question, unfortunately, is practically a unanimous NO! This unpleasant evaluation should not be charged indiscriminately to failure by all students of engineering or to the ineffectiveness of able and sincere teachers of English. The writer believes that this negative appraisal can be directly attributed to the very nature of prevailing English programs and to the lack of well planned follow-up writing requirements and standards demanded by the teachers of engineering subjects.

Let us get down to specific results obtained in a survey of the writing performance of Junior and Senior students. Papers were gathered from at least one entire section of Juniors and Seniors in each of the five major divisions of the college. Students were not informed that the English was to be used for the special study. These papers were written outside of class as regular assignments. The 149 papers were then read and classified as Good, Fair, Poor, and Not Passed. Nearly every objectionable error was noted, analyzed, and classified. The approximate length of papers varied from 130 to 1000 words.

Of the 149 papers reviewed, 48 or 32% were Good, 60 or 40% were Fair, 27 or 18% were Poor, and 14 or 10% were "Not Passed." Thus one may surmise that of every ten upperclass students 3 write *Good* papers, 4 write *Fair* papers, 2 write *Poor* papers, and one writes a *Not Passed* paper. It was further observed that the results were poorer as the papers grew longer. Indications are that a student does not positively demonstrate his strength or weakness in less than from 300 to 500 words.

When only 3 out of every 10 juniors

and seniors—probably the same number holds for graduates—write *Good* papers, it is little wonder that teachers of upperclass students and employers of college graduates complain about the level of engineers' performance in English.

The analysis and classification of the errors yield results which are of far greater significance and value than the appraisal of overall quality of the written papers. The following summary omits spelling errors. Although spelling errors were recorded, the results demonstrated that many misspelled words were due to carelessness and that in an appreciable number of instances the students were able to correct their errors without the use of a dictionary.

A. Coherence, Clearness, Smoothness	48.5%
B. Grammar	22.6%
C. Diction	15.1%
D. Punctuation	13.8%

Thus one might conclude that about half of the difficulty in writing consists of inability to communicate ideas and thoughts clearly. Only about one-quarter of the errors are chargeable to grammatical errors and a similar ratio to diction and punctuation combined. The graders of these papers did not aim at perfection but merely at determining the average literacy and intelligence of work generally accepted.

The commonest errors are easy to detect. Eight easily detected errors out of thirty-one types are responsible for more than half of the mistakes commonly made. Only two are errors in formal grammar. All eight are such as to make the students' written and spoken work incorrect, clumsy, and obscure.

The teacher of sophomores, juniors, and seniors could be of invaluable service to his students if he would constantly urge them to avoid the following Eight Commonest Language Errors:

Clearness
1. General vagueness, awkwardness, inexactness.
2. Faulty reference of pronouns.

Grammar
3. Disagreement of subject and verb.
4. Disagreement of pronoun and antecedent.

Diction
5. Wrong word.
6. Faulty idiom.

Punctuation
7. Fragmentary statement written as a sentence.
8. Confusing lack of internal punctuation.

These observations are for one institution. The engineering faculty could profitably join with the department of English in any school to make a survey of how freshman English "Takes." Should such a survey be made, it is important that the paper should be written as a *regular* requirement in junior or senior courses, that the papers should be at least from 300 to 500 words in length, and that the students should not know that the papers will be scrutinized for English as well as for technical content. This type of check-up is good for the student, for teachers of technical subjects, and for the teachers of English.

How Well Do Young Engineering Graduates Write?

On the basis of general comments by their employers and by the graduates themselves, and of results obtained by actual surveys in industry, there appears to be a greater inability to meet the demands of industry for

effective writing and speaking than for effective engineering and scientific work.

In a survey of several thousand practicing engineering graduates, good English was considered to be indispensable or of considerable value by 60 per cent. Of this number about 25 per cent recommended the inclusion of more English courses in the Engineering curricula, and another 25 per cent were actually continuing to study English after graduation.

One large employer of engineering graduates made a comprehensive and careful survey of "The Young Engineer and His English." It was found that from the point of view of young graduates, the preparation of letters, memoranda, reports and other written material consumes about 25 per cent of their time. Contacts with supervisors, other employees, and the public consume another 20 per cent of their time. Nearly 40 per cent of the men found their written assignments more difficult than scientific and technical phases of their work. About 30 per cent found it difficult to express their ideas orally, either in individual conferences or with groups.

In this same survey, more emphasis on English was favored by 90 per cent of the men; more emphasis on speaking was requested by over 90 per cent; and more literature was favored by only 25 per cent.

An analysis of the survey from the viewpoint of the supervisors reveals that in the writing of letters, memoranda, and reports about 75 per cent of the young graduates use correct English, 64 per cent use clear English, but only 30 per cent use convincing English. The percentages of those who speak correctly, clearly, and convincingly are lower for speech than for writing. The specific defects occurring most often are in the order of their frequency: poor sentence structure, limited vocabulary, and poor organization of material.

It should be realized that these comments apply to young engineering graduates selected from many engineering schools representing a large variety of institutions and a wide geographic distribution. Therefore, it seems reasonable to conclude that in many schools definite steps should be taken for an improved English program.

Why Not Develop a Realistic English Program?

To stimulate creative thinking leading to the early implementation of effective English programs in those colleges and universities which will have the courage to initiate them, four recommendations are presented.

1. Stop teaching high school courses in English as freshman English in college.

2. Develop completely new motivations, objectives, contents, presentations, and functions for the courses as well as for the teacher in the proposed revitalized English program.

3. Introduce a policy, system, and method for the review by competent faculty members of at least one paper written each term of the sophomore, junior, and senior years. These papers should be written as a regular requirement of the courses in engineering subjects.

4. Insure that a full course in "Report Preparation" completes the senior year of each engineering curriculum.

To develop each of these four points a bit more completely:

1. *Emphasis on Reading, Writing, Understanding, Thinking, Learning, and Speaking:*

A review of the statements for freshmen English in college catalogues and a study of the course outlines reveal that in most cases the objectives, contents, and teaching methods are identical in nature with those of high school English programs except that the rigor may be more exacting, the teachers more experienced, and the subject matter extended. It is about time to place more faith in the seriousness and adequacy of the English programs in high schools. Then more responsibility could be placed upon the freshman student to apply accurately and effectively what he learned in high school English. Specifically, the proposal offered here is that instead of devoting time to the re-teaching of grammar, composition, and rhetoric, the student should be expected to apply what he has learned in high school to the writing, reading and understanding requirements of the course in college English. Then, the emphasis could be placed on reading, writing, understanding, thinking, learning, and speaking. In other words, both the student and the teacher of English would be working on a stimulating and mature level of mental discipline instead of devoting precious hours to the re-drilling of rules and regulations which have been or should have been acquired in high school. Grammar, composition, and rhetoric would of course be important elements in the student's performance. But the student would be impressed with the idea that these skills are expected of him. This approach should convince the student that what he has once studied and learned he is expected to apply effectively by his own volition.

Those students whose work in English throughout the freshman year is consistently substandard insofar as grammar, composition and rhetoric are concerned should be obliged to take and pass a "Practice Course" during the following year without credit toward graduation.

To make this plan effective, should the student need to take the "Practice Course," his final grade in English should be withheld until such time as he meets the standards of the "Practice Course."

2. *The Revitalized English Program:*

The entire freshman year in English should be revitalized as an orientation course in an introduction to the Humanities broadly and practically interpreted. The student can in this course become aware of engineering in its relationship to society; he can develop an interest in people and stimulate an intense civic consciousness. His reading sources can be among the many fine general and technical books, magazines, pamphlets, and newspapers of the day—of the period and time in which HE lives. Then as he matures, and after he has developed the urge to read materials of recent publication, he will develop the urge to read what great men of all time have thought and expressed in their writings.

One specific suggestion is to have the student select a topic of particular interest to him during the first week of the term. Then, let him develop this topic for the remainder of the term by reading, writing, and discussion about his chosen subject.

3. *Writing Requirements Beyond the Freshman Year:*

During each term of the sophomore, junior, and senior years in every

engineering curriculum, the department should designate some course in which occasional papers of consequence will be written as a regular requirement. Then, some designated personnel of the department of English would select at random a particular unannounced written assignment for scrutiny as to its merit. Those students who persistently present substandard written material may be expected to enroll in a drill course such as described in foregoing Item 1.

This program is important because it gives the student four years of continuous experience in writing and the benefit of departmental as well as English counsel. Then, when his employer assigns some writing responsibilities to him, he will not have to tackle his assignment after three lean years of little writing and less organized formal discussion.

4. *Report Preparation:*

In recent years it is becoming increasingly recognized that the synthesis of ideas and knowledge is of greater importance and value than the idea or knowledge itself. As the young engineer matures and as he is entrusted with increasingly broader and more intense responsibilities, he finds that he is called upon to write more letters, more memoranda, more articles, and more reports. As a matter of fact, in his early days as an engineer he is quite likely to be called upon to write a report to his superiors. On the merit of the technical content and literary effectiveness of this report will depend his recognition and advancement.

The inclusion of a "Report Preparation" course in the senior year of all engineering curricula provides the student with the opportunity to study intensively a problem of his own choice. Reports of this kind give the student experience in gathering and sifting information, in presentation, analysis and interpretation, and in the important skills of reasoning and judgment. The preparation of a report calls upon the engineering student to synthesize his knowledge through the medium of graphical, mathematical and linguistic expression, including the subtle application of aesthetic principles to produce a pleasing and desired effect.

Are We Ready to Accept the Challenge?

This brief analysis of the problem of necessity touches only the high spots. The writer has tried to stimulate each person to provide his own answers to the questions:

Where are we?

What do we have to offer?

Does freshman English "Take"?

How well do young engineering graduates write?

Why not develop a realistic English program?

Are we ready to accept the challenge?

The answer to the last question will determine for each of us whether we will return to our homes and relapse into the same routines of working and thinking, or whether we will realistically tackle one of the very important problems confronting engineering education. In every case the particular methods for implementing these major policies and objectives will need to be developed cooperatively by the faculties of English, science and engineering. If we choose to accept this challenge, then there will be a great deal of creative thinking and work to do and many people to convert and convince.

TESTS FOR GUIDANCE AND COUNSELING

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Engineers are amazingly versatile creatures. Present demands for technically trained people reflect this fact; engineers and scientists are being placed in positions ranging all the way from top-notch management administration to routine analysis and testing. Thus it is that engineers are not employed solely in purely technological pursuits. They are employed also as managers or supervisors, as technical salesmen, and in top flight executive positions for which engineering training may not be a necessity but is a great aid.

This fact has been seized upon by several writers as a major cause of present severe shortages in technically-trained personnel. These writers call for a system which will insure that engineers pursue purely technological activities in their industrial employment. This, these critics argue, will significantly ease present shortages of engineers and scientists, result in increased job satisfaction for technical people, and promote "more efficient" utilization of technical manpower.

Counseling Has a Place

Fortunately for industry, the reasoning behind the above arguments has been recognized to be fallacious. Engineering educators, by and large, have been gratified at the versatility shown by their progeny. Steps have therefore been taken to modify engineering curricula toward better industrial preparation for young engineers.

This effort certainly has been in the right direction. It needs to be accompanied, however, by equally intensive efforts to increase the participation of engineering educators in the guidance and counseling of students.

The word *counseling* may have unfavorable connotations for many of the readers of this paper. Examples of poor counseling are numerous. Inexperienced, poorly trained, and often maladjusted persons posing as "counselors" have, by their abortive efforts, misguided the destinies of countless individuals. Fortunately, however, the bulk of professional counselors are competently and quietly continuing to do an effective job.

They are taking steps to purge their ranks of the undesirable elements mentioned above. Let it be known at the outset, therefore, that the author has heard of, recognizes, and sincerely deplores the many instances in which the counseling function has been seriously degraded. This is not to say, however, that *good* counseling is not desirable and necessary.

Expert guidance and informed counseling promote close working relationships between faculty members and members of the student body. It is important indeed that engineering

students have ready access to the advice and guidance which only informed and experienced faculty members are qualified to give. Through such relationships the student gains a realistic view of the industrial world which he is preparing to enter. His educational career also takes on new meaning. Course offerings become more interesting and vastly more palatable. Purpose and direction are added to the enterprise, and the student hearkens to the excitement of planning the journey toward his goal.

Granted that the guidance function is desirable and necessary in modern day engineering education, what are the major guidance problems to be faced? What methods may be most useful and appropriate in carrying out these guidance functions? Finally, what aids are available to give the faculty counselor added information about the individuals he is advising?

Are Engineers Dissatisfied?

Several writers [1] have speculated about matters which, when taken together, might be referred to as "the engineer's plight in industry." It has been said, for example, that engineers in industry suffer from chronic dissatisfaction. It has been said further that a major part of this dissatisfaction stems from a basic conflict between management methods and the scientific methods employed by the professional engineer. Actually, many of the points made by persons writing in this vein are based on faulty reasoning. It is a simple matter to point up some of these errors. Doing so serves to highlight some of the areas and problems requiring special attention from engineering educators.

(1) First of all the term "professional" is bandied about far too freely. A young engineering student, if he is to believe much of what he reads, will be lulled into feeling that possession of an engineering degree automatically carries with it the stamp of "professional engineer," thereby entitling the holder to much of the recognition, status, and privileges implied by the term "professional."

Bombarded by these arguments and quickening to the sweet taste of professional privileges, the engineering student needs to know and appreciate the broader connotations of the term "professional." Most of all, he needs to become aware that true professional status does not derive from such artificial (though important) supports as college degrees, group membership, and secret terminology. Moreover, he needs to learn about the duties as well as the privileges of professional status.

For example, he must take unto himself his profession's code of ethics. He must learn that first allegiance is not to himself, but rather to his profession, his employer, and to society. Recognition that the achievement of professional status is not a "cut and dried" affair, that it is a goal to be won through long and constant effort, will significantly lower the expectations of the young engineer who is about to enter industry. Giving engineering students a more realistic view of themselves and their profession is one primary need that engineering

[1] See for example, George Odiorne, "The Trouble with Engineers," *Harper's Magazine*, January, 1955, pp. 41–46, and David G. Moore and Richard Renck, "The Professional Employee in Industry: The Unhappy Engineers," IRC publication IV, University of Chicago, 1952, pp. 9.

educators, in carrying out their guidance function, can fill.

Engineers Differ

(2) Just as serious, possibly, is the prevailing notion that engineers are all the same, that they are of a certain mold, and can be handled in a definite, readily prescribed manner. Fortunately (or, unfortunately, depending upon your view), such a stereotype is far too simple. As has been mentioned previously, engineers carry out a variety of job duties ranging from top-flight administration to routine analysis and testing. Obviously, individuals possessing different patterns of abilities, interests, and personality traits differ sharply in the extent to which they are suited for these various functions. Because different engineers are differently "suited" to carry out various functions, instances of serious waste or misapplication of technical manpower are not uncommon. For example, an engineer may spend years in unsuccessful pursuit of graduate training, a career in sales engineering, a career in research, or some other engineering specialty. Needless to say frustration, dissatisfaction, wasted effort and time are the unwanted by-products.

Educators Need Assessment Techniques

Taking these facts into account, it behooves the engineering educator to familiarize himself, as best he can, with all methods applicable to the measurement of engineering aptitudes, interests, and personality traits. Supported by *objective* and *valid* methods of appraisal, the guidance burden will be significantly eased. Working with the student, the faculty advisor will be able to do a better job of pointing out the area or areas in which the student may expect to be most productive and satisfied.

In fulfilling this guidance function, psychological testing can play an important part. Unfortunately testing has received a bad name for several reasons. Chief among these is that most tests have not been appropriate for the measurement of the highly specialized abilities and interests possessed by engineering graduates. Thus, use of inappropriate tests, often administered and interpreted by poorly trained technicians, has resulted in attaching a general stigma to the entire testing approach.

Furthermore, many test makers have failed to provide sufficient evidence bearing on the validity of the tests employed. In other words, they have been unable to show how test scores are related either to job effectiveness in different industrial functions, or to the relative success with which different engineering students pursue their undergraduate or graduate studies.

Thus, the widespread use of inappropriate and poorly validated tests has served to discredit the testing movement—at least, so far as the testing of engineering students is concerned. Recognition of these shortcomings has led to an extensive personnel research program designed to develop *good* objective guides which may aid the engineering educator in accurate occupational analysis. The research program has addressed itself to the following questions:

- How do engineers who perform varied functions differ from each other?
- How can these differences be identified and measured?

- Which differences are most important in determining success or failure?
- Finally, can such differences be reliably measured? If so, can these measures be used to predict where a given individual will do the best job?

New Test Measures Engineering Achievement

The first step in the research program was the development of a high level engineering achievement test, the *Minnesota Engineering Analogies Test* (MEAT).[2] This test is the result of efforts to combine features of an abstract reasoning test with those of a comprehensive engineering achievement test. It is an attempt to build an engineering ability test which will accurately identify high level engineering capacity and which will be *acceptable* to the engineers who take it. Preliminary research suggests that this effort has met with substantial success. For example, engineers doing different types of engineering duties characteristically score differently on MEAT. This is an important finding because it shows that scores on this test may give some clues about where a young engineer might do his best job. Figure 1 shows how this works.

This figure shows the middle fifty per cent of scores for three groups of engineers engaged in different engineering duties. A quick glance at the chart reveals that pure research engineers score highest, followed in decreasing order by development engineers and sales and technical service engineers. This information can be useful in the guidance of engineering students and applicants for admission to engineering.

Suppose a young man scores 37 of a possible 50 on MEAT. It is obvious that he is well above the average of pure research engineers. Based on his engineering knowledge and his ability to reason abstractly, an estimate is warranted that he will make a top-notch pure research man. On the other hand, a second engineer scoring 28 on MEAT might be fairly typical of development engineers. The odds are that he would serve efficiently on a development job, but that he might be somewhat less effective as a pure research engineer.

[2] Minnesota Engineering Analogies Test consists of problems of the four-alternative multiple choice variety in analogy form. Examples of some of the problems in the test include the following: (The correct answers are italicized)

(1) Add : Subtract :: multiply : 1) integrate 2) *divide* 3) magnify 4) differentiate

(2) In a triode,
Spectators : turnstile :: plate current : 1) cathode 2) plate 3) anode 4) *grid*

(3) Rate of fluid flow : electric current :: pipe friction : 1) electromotive potential 2) *electrical resistance* 3) conductance 4) resistivity

In order to answer any one problem correctly, an engineer must know not only his subject matter; he must be able also to perceive and identify the appropriate relationships. Psychologists have known for a long time that his ability to perceive relationships is related in a subtle way both to general intelligence and to abstract reasoning ability. It is likely, therefore, that *Minnesota Engineering Analogies Test* is an effective measure not only of what an engineer knows, but also of how well he can use the facts he does know. Development of MEAT has been carried on over a span of three years during which over 1300 engineering students and employed engineers have taken the test. It has been published and is currently being marketed by Psychological Corporation, 522 Fifth Avenue, New York City.

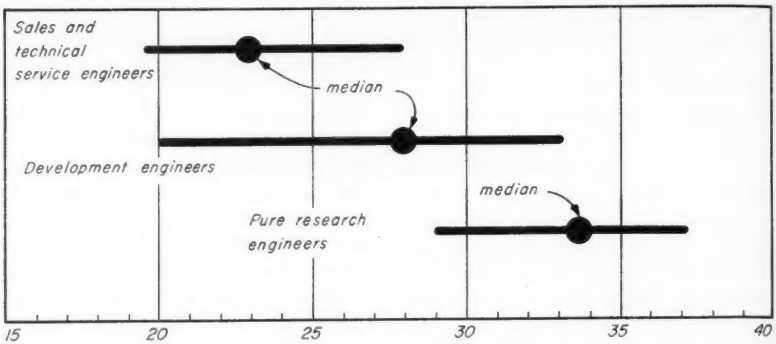

FIGURE 1. The middle fifty per cent of scores on Minnesota Engineering Analogies Test for three groups of engineers with different duties. Note that the median score for sales and technical service engineers is 23, for development engineers is 28, and for research engineers almost 34.

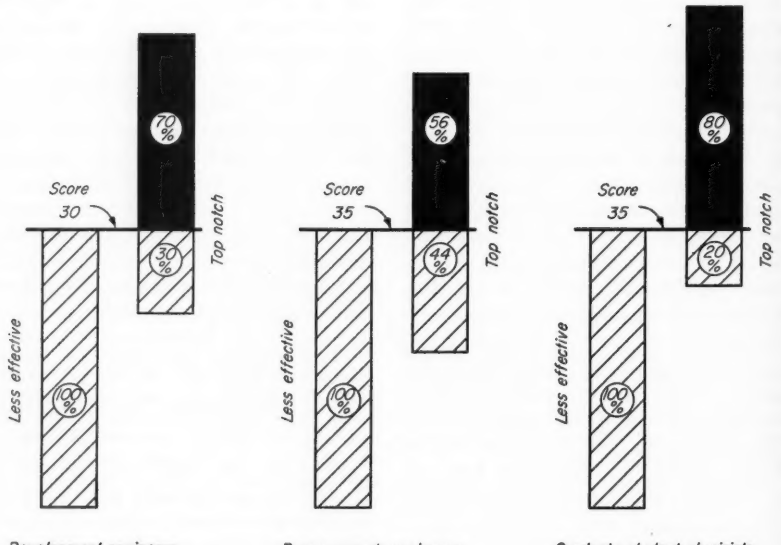

FIGURE 2. Per cent of superior and less effective engineers and students, above and below certain critical scores on the Minnesota Engineering Analogies Test. Note that in Firm A, 100% of the less effective development engineers scored below 30, while only 30% of the top notch men made 30 or below. The same division holds slightly less well with the research engineers of Firm B (100% against 44%), and somewhat more so with the graduate student physicists of University A (100% and 20%).

MEAT Validity Is High

Evidence bearing on the validity of MEAT is given in Figure 2. This Figure shows how scores on the test are related to engineering effectiveness as judged by supervisors of employed engineers and professors of students in graduate training. Supervisors and professors were asked to rank the engineers under them in terms of overall effectiveness. Figure 2 shows how well scores on MEAT discriminate between "top notch" (ranked in the top quarter) engineers and "less effective" (ranked in the bottom quarter) engineers. For example, in Firm A,[3] not one of the less effective development engineers scored above 30, but 70 per cent of the top notch development engineers did so. MEAT also does a good job among pure research engineers. In Firm B [4] none of the less effective pure research men scored above 35, but 56 per cent of the top notch research engineers did so.

Finally, it is apparent that the test also accurately identifies different levels of effectiveness in graduate training. None of the less effective graduate students in a group of M.A. and Ph.D. candidates majoring in physics at a well known southeastern university scored above 35, while 80 per cent of the top notch graduate students did so. Though scores on a test such as this certainly must be used with caution, evidence for the validity of the engineering test as a measure of effectiveness is impressive. Used in conjunction with other lines of attack, such as school grades, expressed desires, and general personality factors, this type of information can aid significantly in the educational and employment guidance of engineering students.

Measurement of Interests also Important

The development of *Minnesota Engineering Analogies Test,* therefore, may represent an important step toward supplying answers to the questions outlined earlier in this paper. This development has concentrated, however, only on the measurement of knowledge or aptitudes. What of the vocational *interests* or motivation of engineers performing different functions? It is logical to assume that a pure research engineer may differ sharply in interests from a good sales engineer. If this be so, objective measurement can give further important information for the guidance of the student.

[3] Engineers tested in Firm A were chemical engineers engaged in developmental research activities. None held a graduate degree.

[4] Engineers tested in Firm B were highly experienced electrical and electronics engineers engaged in pure research. Many held Master's or Ph.D. degrees.

[5] *The Strong Vocational Interest Blank* is a listing of 400 names, occupations, book and magazine titles, school subjects, and activities. For each item, a person taking the Inventory is asked to indicate whether he Likes, Dislikes, or feels Indifferent toward the item. Experience with the test shows that persons in the same occupation give similar answers. Thus the Inventory can be scored on how similar a person's answers are to those of successful men in any of 40 major occupations. Scores can be obtained for occupations ranging from carpenter and farmer to engineer, physicist, lawyer, or author-journalist. Extensive research with this test shows that a man's measured interests change little after age 20. They may be expressed in different ways at different times during his life, but the basic wants, desires, and propensities are strikingly constant.

As a matter of fact, preliminary research with the *Strong Vocational Interest Blank*[5] shows that measurement of interests can predict future engineering effectiveness. One study of interests showed that research engineers characteristically obtain markedly different results from those of sales engineers. Top research engineers showed measured interests similar to those of physicists, chemists, and mathematicians. Top sales engineers, on the other hand, were more like sales managers or real estate salesmen in measured interests. The most significant finding was that the research engineers who were rated as most effective by their supervisors were those who also scored highest on the basic science occupations (physician, chemist, physicist, mathematician).

These findings with the *Strong Vocational Interest Blank* are of special significance. They show that an engineer's interests (quite apart from ability) may be important in determining where he will do the best job and how good a job he will do. Research is now being directed toward determination of the characteristic patterns of interests shown by engineers performing different industrial duties, such as pure research, production, sales, and administration. It is hoped that when these data have been collected and analyzed, valuable added information will be available which can help in pin-pointing the type of engineering function most suitable for the young engineer. Such knowledge, obviously, could significantly ease the guidance and counseling problems faced by engineering educators. Objective information, based on acceptable tests with *proven validity*, can be applied both by engineering students and their advisors in planning educational programs appropriate to demonstrated basic abilities and interests.

ASEE PROCEEDINGS VOLUME FOR 1954-1955

Volume 62, 1955, of the series, *Proceedings of the American Society for Engineering Education*, all text material of the JOURNAL from September 1954 through June 1955 (excluding the annual meeting program and the directory of members) is now available from the headquarters of the Society. The *Proceedings* are prepared substantially by omitting the covers, advertising, and other ephemeral pages of the monthly JOURNAL editions. The cost of the bound volume, 832 pages, with four pages of subject index and two pages of author index, is $6.00. Orders and remittances should be sent to ASEE Headquarters, University of Illinois, Urbana. Copies are supplied without charge to associate institutional members.

MIT'S ENGINEERING PRACTICE SCHOOL—AN EFFECTIVE TRANSITION TO MATURE ENGINEERING

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In the over-all education of engineers there is a rather ill-defined period between the time when formal college education ceases and when an individual attains the position of a responsible, practicing engineer. It is in this period that there may be a sharp transition from the academic approach to the industrial approach. It is also in this period that there may be some loss in enthusiasm or morale as it becomes obvious that most subjects at school were considered on an "ideal" basis and that this basis usually is not directly applicable in practical situations due either to the complexity of actual problems or to the paucity of the data necessary to obtain an answer. Judgment, common sense, the ability to make simplifying assumptions, must be brought into play. These assumptions are not guesses—but intelligent approximations based on the theory learned in college. It is also at this point that many less technical virtues are emphasized, such as the ability to communicate effectively, and the ability to work within a group undertaking.

This transition period may be said to end in the development of a mature engineer, and until recently the course of this development has been left almost completely to the individual. Now, however, there is an awareness in industry that there should be a type of education which would accelerate the development of maturity in the engineering profession; an engineering internship might be appropriate. That this is industry's feeling may be verified by the newly placed emphasis on trainee programs. Some of this feeling has also sifted back into the colleges and may be noted by the growth of cooperative programs and in much of the course work wherein applications of theory are stressed.

At M.I.T. an Engineering Practice School program is offered, which it is believed decreases the transition time required to adjust from the college classroom type of work to that encountered in modern industry. The mechanism and aims of this program are discussed here and compared both to the collegiate cooperative program and to the type of training program sponsored by industry.

Industrial Training Programs

The report, "How to Train Engineers in Industry," which was issued recently by the Professional Engineers Conference Board and the National Society of Professional Engineers, has clearly emphasized the growth of industrial training programs. The general keynote of the report was that at the present level of wages paid to new engineers,

coupled with the shortage of engineers, it is economically advisable to accelerate the development of a new employee's professional potential by some sort of planned training program. R. P. Dinsmore [1] has said that the employer obtains "young men (who) have the favorable characteristics of being energetic, optimistic, enthusiastic, flexible in their ideas, and last, more durable than older men. On the other hand they are likely to exhibit the unfavorable characteristics of being unseasoned, underdeveloped in judgment, rash, inexperienced, undiplomatic, shortsighted, and weak in team spirit."

Although industrial training programs vary considerably in scope and in quality, the teaching techniques are, in most cases, not formalized but usually involve one or more of the following: role playing, job rotation, conferences, study courses. Many industries also aid employee engineers in obtaining advanced courses or degrees at nearby colleges and universities. The point of interest here, however, is the fact that by detailed programming, industry has found that it is profitable to "educate" the engineering graduate into the ways of competitive industry. This post-graduate or pre-industrial education involves not only the usual introduction to company policies but also the development of thinking and action reflexes as applied to practice.

The advantages of such engineer training both to industry and to the engineer trainee are obvious. The industry benefits at an earlier date from the engineer who is capable of undertaking responsibility, and the engineer enjoys an earlier professional, and financial, recognition. The main disadvantages of the programs lie not in the idea but in the application. Most programs are administered with little close supervision and the teacher is more often than not a line supervisor who has this added responsibility thrust on him in addition to his other duties. By no means is such a teaching method inherently bad—it may, however, be inefficient since there are many occasions when the supervisor has neither the time nor the experience to evaluate and guide the development of the young engineer.

[1] *Chem. Eng. Prog.*, 50, 109 (1954).

Cooperative Programs

Cooperative programs ordinarily provide excellent educational opportunities for young engineers. By combining classroom theory with practical application in alternating periods of time, a man quickly learns the necessity and limitations of theory in practical applications. This type of training for engineers suffers one serious drawback—the possibility of having poor or uninterested supervision in the plant phase of the program. Occasionally a student will spend all or most of his time at a plant on one problem or one type of work with little educational development except a specific factual gain about the problem at hand. The ability to work with or lead a group, the ability to deliver a competent technical talk or write a concise, clear report may or may not be developed, since the choice of problem and method of presentation is almost wholly at the discretion of his immediate supervisor.

There are some very conscientious supervisors who do their utmost to guide and help the trainee in his work, but unfortunately there are many, as in the case of the industrial

programs, who have neither the time nor patience to help, encourage, and criticize constructively the engineer trainee. Most universities or colleges with cooperative programs have a Coordination Department, the duty of which is to keep aware of what kind of work the students are engaged in. This is a step in the right direction, but until the immediate supervisor can be convinced of his duty to guide and encourage the cooperative student, maximum utilization of the student's time, for the student's benefit, cannot become a reality.

M.I.T.'s Engineering Practice Schools

The Massachusetts Institute of Technology has long realized the need for cooperating with industry to develop individuals who not only had a reasonably good background of fundamentals but also possessed other desirable traits such as the ability to reason, to express oneself orally, and to express oneself in writing. A tried and successful method used to develop these latter qualities has been the Engineering Practice School.

Undergraduate or graduate students may enroll in a one-semester course which is designed to be both intensive and comprehensive. For Chemical Engineering Practice, the student has a choice of three different plant areas: Hercules Powder Company at Parlin, N. J.; Eastern Corporation at Bangor, Maine; and Bethlehem Steel Corporation at Lackawanna, New York. The *Oak Ridge Engineering Practice School* is located at the Union Carbide Nuclear Company installation in Oak Ridge, Tennessee. The *School of Chemical Engineering Practice* is primarily for undergraduate and graduate chemical engineers; the Oak Ridge Engineering Practice School is attracting graduate chemical, nuclear, electrical, and mechanical engineers, as well as graduate science students in physics, chemistry, and metallurgy. Both schools are nearly identical in operation, so only one, the Oak Ridge Engineering Practice School, will be described here.

Aims of the Practice School

According to the late Prof. W. H. Walker of M.I.T., acquiring a knowledge of science is easier than applying this knowledge intelligently and successfully to the solution of technical problems. In recognition of this fact, the primary objective of the Practice School is to develop the student's ability to apply fundamentals by assigning him to a variety of challenging plant problems. Emphasis is placed upon the development of abilities to apply basic principles and good common sense to the solution of technical problems encountered in industry. At the same time, particular emphasis is placed upon the development of skill in public speaking, technical writing, group cooperation, leadership, and economic analysis.

Mechanics of the Program

The aims and purposes of the Practice School are put into action in an unusual way. A resident staff, consisting of an assistant professor and an instructor, is maintained at each station and is responsible for the education of the students. The staff surveys the current plant problems and judges whether they are acceptable by two criteria: (a) are they educational, requiring originality or creativeness of the students and (b) will it be possible, in the time allotted, to achieve results of value to the plant?

If a problem is judged suitable, two or more students are issued a memorandum describing briefly the background of the problem and the specific information desired; a plant consultant is also listed so that the students will have a direct liaison with the industrial staff. The problem may last from a few days to several weeks. The average time at Oak Ridge is two weeks. Thus each student will be assigned eight or nine different problems per semester.

In no case is a man assigned to a problem alone, for cooperative effort is one of the factors stressed in Practice School work. In sections of three or more men, a group leader is appointed who is responsible for coordinating the work and seeing that the assignment is completed on schedule. The responsibility of being a group leader for an assignment is rotated among the men.

A record is kept of each assignment so that each student will have different kinds of problems during the semester. The five general classes are: research, development, design, production, and technical service. By working in these areas the young engineer can evaluate his own potentialities and will be able to orient himself with regard to the type of future employment for which he is best fitted.

A few problems assigned may involve only a theoretical or economic study, but over half require some kind of experimental measurements. Because the experimental problems encountered at Oak Ridge may vary from a delicate physics experiment to the construction of a chemical engineering pilot plant, the Practice School is provided by Union Carbide Nuclear Company (subcontractors to the AEC) with a large laboratory and well equipped machine shop.

Solution of the Problem

Each group or team has the responsibility for the solution of its assigned problem. The first step in the solution of the problem is to become acquainted with the existing theory, operations, and equipment involved. Then the phase of the problem to which the investigation will be confined must be determined. These decisions may be accomplished by conferring with the plant men for their ideas and by consulting the literature, including plant reports, to determine what information is already available. Once the specific problem has been defined, it must be analyzed to determine the experimental data and test equipment needed, the precision required, the results expected, and the method of presentation.

The group then presents its plan of attack to the staff for approval. The staff makes criticisms and suggestions, but as far as possible the final decisions on the procedure are left to the students. After a plan which is acceptable to both the students and the staff has been outlined, it is taken for approval to the plant supervisor in whose division the work will be done.

Following this approval, the necessary experimental equipment is built and the actual test is performed. The assignment is complete when all results have been analyzed and the conclusions and recommendations have been properly submitted in a written report. Throughout, the importance of scheduling properly to meet the completion date is emphasized.

At Practice School it is emphasized that engineering is a group undertaking, and achievement may hinge

strongly on effective communication among the men in the group, so that the results of a technical investigation have little utility unless they can be understood and used by others. Thus, the students realize that it is of prime importance for an engineer to develop the ability to present technical reports with clarity, conciseness, and forcefulness, since others will often judge ability by the quality of presentation. It is also pointed out that just as one can command respect from his readers with a well-written report, he can impress an audience even more with a good talk. In the oral situation, he has considerably more chance to use the forcefulness of his personality in transmiting ideas.

Practice School men gain facility in writing by reporting the results of their investigations. An assignment is not complete until an acceptable written account of the work has been submitted. When the first writeup is turned in, it is reviewed by the staff for such points as scientific and engineering content, clarity and logic of text, completeness, grammatical construction, and form. It is then returned with a list of criticisms and suggestions. After being revised by students, it is resubmitted. This process is continued until the writeup is in a satisfactory form, after which it is reproduced and distributed to interested plant and laboratory personnel.

When each problem is completed, an oral report also is given by the group leader. The presentation is criticized freely both by staff and students. The ability to deliver a better-than-average oral report is so essential that, in addition to the reviews given after completion of the problems, several additional seminars are scheduled throughout the term. These talks, which may be either on optional or assigned subjects, are recorded so that the speaker can play them back later and judge his own style and delivery.

Students get further realistic experience in oral reporting when summaries on their investigations are presented for the benefit of plant personnel. The question period which follows is important, for it tests the speaker's grasp of his subject and his ability to give promptly a direct and satisfying reply to a specific question.

There is no formal grading scheme, but the final evaluation represents a composite opinion of the staff, fellow students, and consultants. Cooperation, leadership, self-reliance, and other such qualities are weighted equally with technical competence.

The Practice School approach may be summarized by noting a paragraph in R. L. Wentworth's paper in the 1951 Engineering Society of New England Essay Contest, "The graduates of Practice Schools have developed an alertness to practical problems that makes them immediately valuable on the job. For example, knowing how and where to buy steel stock can be of equal value with knowing how to determine its physical properties. But strangely enough, this kind of information, which can be picked up without much more effort than keeping the eye and ear open, is usually neglected. The common phrase to described this property is 'well-rounded.'"

THE INTEGRATION OF ECONOMY CONCEPTS IN THE CHEMICAL ENGINEERING CURRICULUM

ROBERT S. ARIES

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and RUDOLF M. CZINER

Consulting Economist

A paper presented at the 63rd Annual Meeting of the ASEE, Pennsylvania State University, June 22, 1955.

In order to determine the extent to which economy concepts have been integrated into the chemical engineering curriculum, we made a survey of all Departments of Chemical Engineering in the United States and Canada. A brief questionnaire was sent, asking:

(1) What courses *specifically* dealing with the economic aspects of chemical engineering and/or the chemical industries are included in your curriculum?

(2) Were such courses given in 1946 (ten years ago)?

(3) If there are no such courses, how are economic aspects introduced into the curriculum?

The return of completed questionnaires was outstanding. From our experience in mail interviews, a 30 to 40 per cent return is considered excellent. In this case, 80 per cent of the chemical engineering departments completed and returned the questionnaires (or 100 out of a total of 125 departments in the United States and Canada)—this despite the fact that they were busy with final examinations, grades, and graduations. The cooperation of the schools—in most cases the Department Chairmen—deserves our thanks and commendation.

By their own evaluation, 63 of the Chemical Engineering Departments reported that they currently offer some course which *specifically* deals with chemical engineering and chemical industry economics. This is about a 20 per cent increase over the past decade.

However, upon closer examination, we found that many of the courses listed actually were straight-forward engineering subjects (such as EQUIPMENT DESIGN), into which some economic considerations are integrated. On the other hand, quite a number of the schools which reported negatively do list technology courses which include some phases in the economics of chemical engineering. Such classes are considered as "PARTIAL" coverage.

On this new basis, 44 schools have specific economics courses, another 48 present the subject "partially," while only 8 departments report no efforts to integrate economy concepts into their curriculum.

A review of the titles of such specific economics courses in chemical

TABLE I

ECONOMIC SUBJECTS TREATED IN 52 CLASSES IN CHEMICAL ENGINEERING ECONOMY

Process Evaluation	80	*Management*	28
Production Cost Estimation	16	Financing	7
Investment Cost Estimation	13	Principles of Management	6
Alternate Investments	12	Personnel Relations—Labor	4
Optimum Design	11	Development & Organization of the Corporation	4
Process Evaluation	10	Accounting	3
Economic Balance	8	Break-even Points	3
Profits—Payout Time	7	Interest	1
Replacement Costs	3		
Business	25	*Commercial Chemical Development*	15
Marketing, Market Research	10	Patents	8
Industry Surveys	6	Research Economics	4
Raw Materials	2	Principles of CCD	3
Competition	2		
Sales Costs	1		
Prices	2		
Transportation	2		

engineering is interesting. The 44 schools listed 52 specific courses. There are 22 courses called CHEMICAL ENGINEERING ECONOMICS or ECONOMY. Eight are designated as ECONOMIC BALANCE. Four are called ECONOMICS OF THE CHEMICAL INDUSTRY or simply CHEMICAL INDUSTRY. Three are CHEMICAL ENGINEERING COST EVALUATION or ANALYSIS. Another three cover the subject under CHEMICAL ENGINEERING PROBLEMS. Two courses deal with CHEMICAL ENGINEERING or TECHNICAL ADMINISTRATION. Other titles listed by the various schools are:

THE BUSINESS OF CHEMICAL ENGINEERING
FACTORS IN CHEMICAL ENGINEERING
CHEMICAL ENGINEERING PLANT ECONOMY
ECONOMICS OF CHEMICAL MANUFACTURE
ECONOMICS AND DESIGN
PRINCIPLES OF ENGINEERING INVESTMENT AND ECONOMY
BUSINESS OPERATIONS IN THE PROCESS INDUSTRIES
PLANT LOCATION
PATENT LAW FOR CHEMISTS AND ENGINEERS

One course is called ECONOMIC ASPECTS OF PETROLEUM PROCESSING AND PETRO-CHEMICALS. Ordinarily, you would expect this to be given in one of the Texas schools. Actually, it is a required undergraduate subject at the University of Pittsburgh. As a matter of fact, the five Texas schools which responded indicated no specific economics courses in their Departments of Chemical Engineering. This may be due to the fact that money and raw materials may be so abundant in their area of interest that ordinary economic practices are superfluous.

Obviously, the greatest emphasis is placed on economic evaluations of chemical processes. Such subjects as Cost Estimation, Economic Balance, Profits and Payout Time are stressed. Next in importance seem to be management problems, such as Financing the Corporation, and Break-even

Charts. Another category is here called Business, which covers Markets, Market Research, Competition, Sales and the other problems involved in actually making even the most efficient process profitable. Subjects directly related to Commercial Chemical Development are mentioned 15 times. It must be noted that this breakdown of the contents of these courses is incomplete, since not every one of the 52 classes was described in detail.

Such economic considerations most frequently enter into classes on EQUIPMENT DESIGN, PROCESS DESIGN, and ORGANIC and INORGANIC TECHNOLOGY.

These courses usually deal with techniques of estimating investment and production costs, examining the components of such costs, estimating profits and payout-time on a process or plant, examining alternate investment opportunities, depreciation of equipment, replacement economics and optimum designs (both from a technical and cost viewpoint).

These economic concepts are important. Unfortunately, all too often these are presented in the form of "ivory tower" problems, somewhat unrealistic to the average businessman and practicing engineer. For example, such economic appraisals often assume that a plant runs at 100 per cent of rated capacity. In actual practice, this is seldom the case. The practical engineer concerns himself not only with capacity operations, but must also know his costs when the plant is running at partial capacity or is being pushed beyond the rated capacity. The quirks of the customers seldom permit any unit to be operated at a uniform rate for any length of time, even with abundant inventory capacity.

Another business factor often overlooked is the fact that minimum costs may not give the maximum return on the investment. An additional refining step, for example, may give a vastly improved and more desirable product. This may involve additional capital outlays and greater production

TABLE II

CHEMICAL ENGINEERING COURSES WITH SOME INTEGRATION OF ECONOMIC CONCEPTS

By 48 Schools Which Give No Specific Ch.E.Eco. Courses

Design	37	Process Industries	3
Technology	10	General Ch.E.	3
Unit Operations	8	Comprehensive Problems	2
Industrial Chemistry	7	Energy & Material Balances	1

A few schools listed classes on related subjects given by other departments, such as ENGINEERING ADMINISTRATION by the Mechanical Engineering Department or ENGINEERING ECONOMY by the Economics Department. Such classes, however, cannot be considered as dealing specifically with chemical engineering economy concepts.

Process Evaluations

The foregoing survey highlights two facts: (1) that most Schools of Chemical Engineering incorporate economics—or rather a dollar consciousness—into some phase of their technical training, and (2) that such integration is mainly in the field of economic process analysis, cost estimating, and return of investments.

cost. However, the improved product may warrant a higher price, may find larger markets and result in additional income, higher profits and a faster payout-time than the minimum cost plant. This factor is often especially true in consumer products, where additional eye appeal may mean higher costs, offset by substantially greater sales and profits.

The optimum economic output of a plant need not be the sum of the minimum unit costs of the individual operating units. The production rate of an entire plant is often a balance of numerous inter-related and co-related factors, such as the efficient use of labor, utilities, sales costs, and storage costs. Optimum economics may depend upon the operation of various units at higher than minimum unit costs.

The problem of the old, "obsolete" plant and product is too often handled on a straight cost basis, whereas other factors may intervene. In many instances, a company will continue to produce a product on which it loses money, simply because it leads to profitable sales in related items. In other cases, the company will continue to sell the item to maintain a complete line of products.

Very often, company management will decide to ignore unfavorable costs and profits. The ability to enter the market first with a new product may eliminate many cost considerations. Securing the market may be more important than optimum returns. The Quaker Oats Company often sold its furfural at a price extremely close to—and at times lower than—costs. The company's double objective was both to stimulate new applications through low prices and to discourage possible competitors by low profits. This long-range approach to furfural production and sales has paid off and is paying off handsomely. Without direct competition, Quaker today sells about 150,000,000 pounds of the chemical.

Another factor not stressed in many of these courses is the human quality of "compromise." You may be able to produce a better product at just a few cents more per pound. Your customer, realizing that your product is much better than his present material, will still refuse to buy. A few years ago, an East Coast company bought out an excellent dielectric casting resin. It had excellent storage life, pot life, curing cycles, dielectric and physical properties. Its selling price was about 10 cents higher than competing resins. The manufacturer was sure that the improved properties justified this higher price. To his distressed surprise, large orders never materialized. The electronic component manufacturers recognized the added values of the resin, but refused to pay the additional cost simply because their present plastics were "good enough"—adequate to do the job.

Here is another problem in profits. Which is more desirable, a profit (after taxes) of $100,000 per year on an investment of $1,000,000, or a profit (after taxes) of $300,000 per year on an investment of $3,000,000? Both have an identical return on investment—10 per cent. The actual decision rests on many factors other than chemical engineering economics, such as:

- The company's ability to raise money.
- The activities of competitors in these two lines of business.

The possibilities of using these processes or products for future diversification.

The trend in the demand for these products.

The organization of the company—its ability to absorb either of these two products readily in its present production, research, sales and distribution set-up.

Government policies.

General company policies and aims.

Of course, the businessman seldom is faced with a situation where two projects have identical returns, but this example does highlight the need for looking further than just costs and profits in managerial decision-making.

The Business of Chemical Engineering

So far, we have seen that Chemical Engineering Economics too often just examines the means and the cost rather than the wants and ends. Markets are usually assumed for the products under consideration. It concentrates on a study of alternate investments and comparative cost studies. R. P. Dinsmore of the Goodyear Tire & Rubber Company recently stated:

"The transition to the industrial atmosphere from the classroom, the laboratory, and the university pilot plant—even though training has been supplemented by some industrial practice school experience—is rather a mental shock to the average engineer. He ceases to be dealing with people whose primary objective is to impart information to him, and instead he is in contact with people whose chief preoccupation is to do a job or a whole series of inter-connected jobs. He learns to his dismay that there are numerous people who do not think that chemical engineering is the ultimate of industrial or business activity and, in fact, he finds out that there are many highly placed people in industry who do not even consider the profession of chemical engineering to be an important means of achieving their business objectives. He learns that even among the practicing chemical engineers the highest type of classical chemical engineering practice is not always employed, and that on many occasions speed is given a far higher rating than precision." (2)

The problems of the young engineer were also well expressed by George Odiorne of Rutgers University in a recent article in *Harper's Magazine.*

"It is on graduation from school that the engineer finds adjustment most difficult, for it is here that he must begin the process of 'unlearning.' Idea by idea, he must clear his mind of 'pure' engineering to make way for such mundane considerations as cost, market-ability, consumer foibles, company folklore, union contracts, and the personality quirks of the chief engineer. In short, all the finely tooled and delicately adjusted machinery that keeps society going." (3)

Giving the chemical engineering student a taste of the business world is a difficult problem—as difficult as making an engineer out of a high-school graduate. Cost consciousness is already well integrated into his curriculum in most schools. But industry has other requirements for the future engineer. To give the average student some insight into the "cat and mouse" existence of industrial activities, a number of Departments of Chemical Engineering have introduced into their curriculum survey courses specifically designed to accomplish these ends. Such courses cover a wide range of subjects, from the ability to communicate to market analysis and marketing to sales and advertising.

Typical Courses

At Cornell University, the Department of Chemical Engineering offers a course called CHEMICAL ENGINEERING ECONOMICS. The stated objective of this course is to:

". . . acquaint the student with many of the economic problems involved in the development and operation of chemical industries. Emphasis is placed on the organization of a chemical company and on the function of the various divisions of a chemical company. Estimation of development, construction, and operating costs is also stressed."

The course is divided into ten parts, starting off with a discussion on THE ECONOMIC CHARACTERISTICS OF THE CHEMICAL INDUSTRY and THE ROLE OF THE CHEMICAL ENGINEER IN INDUSTRY. This is followed by the following subjects:

RETURN ON INVESTMENT
RESEARCH ECONOMICS
ESTIMATION OF MANUFACTURING COST
SALES EXPENSE
TRANSPORTATION AND DELIVERY COST
CHEMICAL PRICES
MANAGEMENT IN THE CHEMICAL INDUSTRY
SOURCES OF CAPITAL

Dr. James Boyd gives an undergraduate course at Columbia University called THE BUSINESS OF CHEMICAL ENGINEERING. This one semester class features speeches by leading chemical businessmen on different aspects of chemical economics. The organization of Dr. Boyd's class is as follows:

ENGLISH, AN ENGINEERING TOOL
CHEMICAL RESEARCH COSTS
COSTS IN PROCESS DEVELOPMENT
COMMERCIAL DEVELOPMENT PRACTICE
SELLING FINE CHEMICALS
OPPORTUNITIES FOR ENGINEERS IN THE PETROLEUM INDUSTRY
SELLING INDUSTRIAL ORGANIC CHEMICALS
COST OF CHEMICAL ADVERTISING AND PUBLIC RELATIONS
THE STUDY OF DIVERSIFICATION OPPORTUNITY
NEW PLANT ECONOMICS
PLANT CAPACITY VERSUS EARNINGS
COST OF NEW CAPITAL

A similar class is given to seniors in chemical engineering at the Polytechnic Institute of Brooklyn, called simply CHEMICAL INDUSTRIES. The stated aim here is a

"Study of the fundamental economic aspects and organization of the chemical process industries, with special attention to the problems encountered by the practicing chemical engineer. Consideration of the background of the industry and the inter-relationship between research, production, and sales with sources and supplies of raw materials, principal and by-products, and the influence of transportation costs. The preparation of surveys, cost analysis, estimates, and patent protection."

Again, the course starts off with a discussion on the BACKGROUND OF THE CHEMICAL PROCESS INDUSTRIES, followed by a treatment of the following subjects in Table III.

In retrospect, these courses deal not only with what is commonly called CHEMICAL ENGINEERING ECONOMICS, but extend their scope to include a survey of the most important aspects of carrying on a chemical business. The stress is on the selling of the products which the chemical engineer

TABLE III

OUTLINE OF CH.E. 217—CHEMICAL INDUSTRIES

Polytechnic Institute of Brooklyn

BACKGROUND OF THE CHEMICAL PROCESS INDUSTRIES

THE MANAGEMENT REPORT
- The Technical-Economic Report for Management.
- Sources of Information.

THE CHEMICAL COMPANY
- Development and Organization of the Process Company.
- Managerial Practices and Evaluation.

PROCESS EVALUATION
- Cost Estimating and Cost Analysis.
- Economic Balance.

PRODUCT DEVELOPMENT AND MARKET EVALUATION
- Commercial Chemical Development.
- Chemical Market Research.

SELLING CHEMICALS
- Marketing of Chemicals.
- Distribution of Chemicals.

SPECIAL SUBJECTS
- Patents for the Chemical Engineer.
- Plant Location.
- Pricing Chemicals.

creates; or, in other words, giving the chemical engineering student an awareness of other business factors than the engineering or processing, which concern him most directly. Aside from becoming cost and profit conscious, the student learns the facts of business life—where and how sales are made—the sources of income—the problems of prospering in our demand and supply economy.

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(2) Dinsmore, R. P., "Growing into Management Through Professional Maturity," *Chemical Engineering Progress*, V. 51, No. 2, pp. 72F–73F (Feb. 1955).

(3) Odiorne, G., "The Trouble With Engineers," *Harper's Magazine*, V. 210, No. 1256, pp. 41–46 (January, 1955).

OPEN SUMMER CONFERENCE ON MATHEMATICS IN ENGINEERING

The ASEE and the National Science Foundation will sponsor jointly a conference on Mathematics in Engineering, at the University of Michigan, Ann Arbor, on June 20–21–22, 1956. Information can be obtained from Frederick C. Lindvall, Chairman, Division of Engineering, California Institute of Technology, Pasadena, California. Topics to be covered will include probability, statistics, numerical analysis and computers, operations research and systems engineering, continuum mechanics and field theory, and the impact of mathematics on engineering and scientific education.

Arrangements chairman is Professor C. M. Thatcher, Department of Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor. Correspondence concerning reservations and requests for detailed programs should be directed to him.

MECHANICS TEACHERS—THEIR CROSS AND THEIR CROWN

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A paper presented at the Mechanics Division luncheon, Pennsylvania State University, June 22, 1955.

Teachers of engineering mechanics not only bear a burden of responsibility in teaching, but also enjoy a reward for the effort expended. Our responsibilities are three-fold. We must (1) impart a knowledge of Newtonian mechanics and engineering methodology, (2) develop and adapt new fields of science for engineering to replenish older ones absorbed by regular curricular subjects, and (3) develop scholars with a professional consciousness, so that our industrial supremacy can continue to protect our way of life and increase the jobs available for a growing population.

Our Responsibilities

Teaching Mechanics. Imparting knowledge of Newtonian mechanics can be either dull and routine or inspiring and creative for the student. Alert teachers are always simplifying the presentation of subject matter and introducing more generalized treatments of advanced topics. The use of partial derivatives and vector analysis, or the introduction of virtual work and varying mass illustrates a few such recent changes in undergraduate courses in mechanics. If, however, our objective embraces the dual responsibility of preparing students for creative design as well as for advanced courses in engineering science, our approach will have to undergo even greater transformation.

At present we limit our presentation to two-dimensional problems in motion or states of stress. Seldom do our beginning courses mention the thermodynamic effects on solids during loading or unloading cycles or give the student a notion of strain in terms of a space derivative of displacement. I realize the pedagogical difficulties involved, but I am amazed at the lack of experimentation in education. Anyone who has been fortunate enough to join ECPD accrediting teams must have become aware of the identical manner in which mechanics is presented throughout the country. All schools include or exclude similar topics. It is difficult to understand why as many energetic young minds as mechanics teaching has attracted should be so lock-stepped.

Various schools have made tremendous strides in the past several decades by introducing graduate work in mechanics. All too frequently, however, older curricular departments have been slow to incorporate this course work as a minor for the graduate programs of their own students. *A wider perspective than the present one is badly needed. Perhaps it can be realized only by a dissolution of* traditional departmental barriers and

academic empires that are still all too prevalent in the engineering educational environment. Engineers of the future will need a much broader training in all of the basic and engineering sciences.

Perhaps the heavy teaching loads, the large classes, the interest in sponsored research with its monthly reports, the increase in administrative red tape, and the need of finding supplemental summer employment have dimmed our reflective powers and retarded our progress. Certainly, they leave little time for the creative mental diversions which stimulate progress in education. A few years ago a well-known member of our group told me that he had entered teaching a generation ago because it offered a contemplative life, but that now he could afford time for a vacation only when undergoing treatment in a hospital. College administrators have a problem to face here; they must grapple with it if engineering education is to keep pace with the continuing discoveries in science.

New Sciences. A responsibility also exists to adapt new fields of science to engineering education. There is no reason why mechanics should not bridge this gap between science and engineering.[1] The mechanics teacher has been responsible in the past for introducing classical elasticity, dynamics, and fluid flow into the engineering curriculum, modifying them and expanding their scope with studies in plasticity, vibration, and transsonic flow. Much of this theory has been absorbed by the more applied courses of traditional curricula, thus strengthening their creative approach. History will continue to repeat itself, and we mechanics teachers will have to exploit new sciences to continue our mission or we will ultimately find ourselves trying to defend an outmoded status quo. *"Revise or retire"* could well be our motto.

Acceptance of this mission could well be a most invigorating challenge. Present-day needs cry for a new approach to the field of engineering materials, embodying the fundamentals of physical chemistry and solid state physics, for the introduction of statistical methods in laboratory experiments, and for instruction in use of digital and analogue computers of both mathematical and physical simulator types. These and other pressing requirements present an opportunity for alert young teachers to serve their calling and enhance their own reputation.

Modification of the discoveries in science for use by engineering represents but half of our obligation. Any university exists as a community of scholars, not only to teach what is already known but to seek new truths as well. Hence, every teacher should be engaged in some research, basic or applied. Such activity will be reflected in and enliven his lectures, and will motivate his students to maximum effort.

Development of the Student. So far this discussion has dealt with the more tangible aspects of subject matter. The intangible effect on the student is no less our responsibility. We must and can spur a greater percentage of our students to develop inquiring minds and imbue them with a zest for scholarship. By example at least, we should inspire them to form a habit of life-long study that will keep them abreast of expanding fields of

[1] Paul F. Chenea, "Mechanics—The Bridge Between Science and Engineering," *ASEE Mech. Div. Bul.*, Vol. V, No. 1, 1954.

technology, to develop a professional consciousness that will avoid unionization of our creative mission, and to broaden their interest in the historical and social heritage of our civilization.

Technical subject matter must, therefore, be taught as a segment of a broader culture; students must be regarded as bearers of the torch we hand them. These students of ours are the intellectual cream of this civilization. Too often we regard them as stupid when they fail to grasp the subject matter we teach. These failures may reflect our own poor presentation. We cannot just present material and fail the hindmost, yet we must uphold professional standards in the face of an apparent decrease in the adequacy of high school preparation. We must impart a knowledge of subject matter and a desire to continue self-study.

Our Rewards

Just as our cross can be subdivided into three broad responsibilities, so too can our crown be composed of three merited rewards. These might be regarded as (1) financial, (2) social, and (3) academic.

All college administrators are endeavoring to raise salary scales so that academic remuneration will more nearly compete with industrial income. Despite their best efforts, much of the improvement has frequently been too little or too late. It seems impossible for college salaries to keep pace with the three per cent increase in purchasing power our technological advance seems to bestow on civilization generally. This fact is rather ironic. I wonder at times whether the citizens of this country have the wealth to pay for the kind of education they say they want. I have faith, however, that this problem will ultimately be solved. Certainly, if the public and industry attack the economic problem as vigorously as we do technical ones, the solution will be forthcoming. It must be approached on a long range basis so that the best engineering minds will continue to be attracted to teaching in ever increasing numbers. Things have not been too bad so far, at least in larger schools, and I am sure that more than a few deans would testify to the fact that at least a few of us have grown fat and sassy on our salaries.

Socially, we have fared even better. Despite the never-ending stream of cartoons and jokes about absent-minded professors, we do enjoy a position of respect in our community and among our professional colleagues. We enjoy that element of security so necessary for creative thought, and we live in a cultural environment that would be considerably more expensive to emulate outside of ivory towers.

Academically, too, we have much to be thankful for. Promotions have been continuous and even rapid for many of our number. Some have even been bold enough to accept the responsibilities as deans of engineering, thus forsaking their sheltered existence. That is a risk all young teachers have to accept. We have been priviledged to watch the students we trained in mechanics assume positions of responsibility in both the educational and professional world. These graduates and we ourselves are contributing immeasurably to the technical problems of our expanding economy and to its preservation.

SUGGESTIONS ON HOW TO TEACH "ENGINEERING SCIENCES"

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The committee "Report on Evaluation of Engineering Education" listed the following six topics of engineering sciences in its recommended curriculum:

1. Mechanics of solids (statics, dynamics, and strength of materials).
2. Fluid mechanics.
3. Thermodynamics.
4. Transfer and rate mechanisms (heat, mass, and momentum transfer).
5. Electrical theory (fields, circuits, and electronics).
6. Nature and properties of materials (relating particle and aggregate structure to properties).

It is suggested here that topics 1, 2, 3, 4, and 6 be combined into one single course, given in the following sequence:

a. mechanics of a rigid body
b. statistical properties of an aggregate of particles
c. heat, temperature, entropy, ideal gas law, first and second laws of thermodynamics
d. transfer of momentum, Navier-Stokes differential equations
e. properties of an aggregate of closely bound particles—elasticity and applications.

Item "a" will include translation and rotational motion.

Item "b" is an introduction to statistical mechanics in its classical version.

Items "c" and "d" are natural results of item "b". The Carnot cycle and actual operating diagrams can be taken up as application problems of item "c". The instructor may work out some examples and let the students do most of the others as homework problems. Similarly, laminar flow can be given as homework problems with some simplifying assumptions. The instructor may point out in the next class that such simplifying assumptions are not always true, and that the solutions to Navier-Stokes equations are not unique and give a qualitative description of energy balance in turbulent flow. This leads naturally to Reynolds number and similitude.

Item "e" is a natural contrast to item "b". Transfer and rate mechanisms can be given as application problems at proper stages.

My reasons for suggesting the above unified course are listed below:

1. It will give the students a deeper insight into engineering sciences.
2. It is usually easier for the students to absorb a few broadly enveloping concepts than to remember a lot of empirical formulas.
3. Being exposed at an early stage to the correlations between thermodynamics and fluid mechanics, the students are better prepared for advanced training.
4. If information theory develops to such importance as to warrant its

inclusion in "engineering sciences," it can be introduced as another branch of item "b" in the sequence.

5. As we are trying to teach more science and engineering in the same four-year curriculum, it may be desirable not to let the students realize the situation. Believing that they are asked to do no more than millions before them have accomplished, they will have greater confidence in overcoming the homework problems. It appears advantageous psychologically to 'sneak' the topics in as a natural succession rather than as an increasingly extensive aggregation of separate courses.

One may object on the ground that the above approach presumes that the students are good in calculus. This is true. However, we may expect their calculus to improve as a result of working constantly on thought-searching problems.

Concluding the above, my suggestion is to present the engineering sciences in two courses:

1. *Non-electrical Sciences*
   Topics 1, 2, 3, 4, and 6 in the report, with optional inclusion of information theory.
2. *Electrical Sciences*
   Fields, circuits, and electronics.

ECRC REVIEW OF CURRENT RESEARCH

Primarily an outline of the current research program being conducted by experiment stations and research foundations of the 116 ECRC member institutions, the present volume is an important source of information about research policy and interests. It should be consulted not only by research administrators, but also by project personnel engaged in preliminary bibliographical searches. Arranged alphabetically by institutions, the 352 pages review research organizations and income, active projects, sponsors, and areas of interest or concentration, with members of research personnel active in each. Forty-six pages of *subject index* for research projects close the volume. So far as member institutions are concerned, these make possible ready location of fellow workers in a specific field.

Edited by Renato Contini, Secretary of the Engineering College Research Council, with an introduction by Harold K. Work, Chairman of the Council, both of New York University, the volume is available at $2.00. Orders and remittances should be addressed to Professor Contini, New York University, University Heights, New York 53. Copies would be useful both in research offices and in engineering or special libraries. Publication frequency is biannual, so that the present edition will be current until late spring of 1957.

A SMALL RESEARCH COMPANY LOOKS AT ENGINEERING EDUCATION

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A paper presented at the 63rd Annual ASEE Meeting, Pennsylvania State University, June 22, 1955.

Rather than posing as a spokesman for a particular branch of industry, I prefer to confine my remarks to certain observations with regard to the technical staff of HRB, a small corporation with about 250 employees. Our company is about eight years old, and started with essentially no capital and only a handful of employees. To build up to our present level, we have had to employ and assimilate each year a staff approximately equal to half of the then existing group. Our growing pains have been many, but not fatal. The business has been largely electronics development, although many projects undertaken have to do with the utilization of electronics rather than with electronic devices themselves.

Assessment

One approach to the subject of engineering education is to try to determine what the important qualities in our engineers are, and then to look at the relationship of these qualities to the engineers' formal college training. A quick check-off list includes the following:

1) Fundamental knowledge of engineering principles, physics, and mathematics
2) Ability to do original work
3) Ability to organize work, to meet time schedules, to estimate the difficulty of the job, and to communicate the results to others
4) Ability to supervise others, both technically and from the management standpoint
5) Enthusiasm for the job, pleasant disposition
6) Ability to satisfy management that the job is under control

Of the six factors listed here, only one or perhaps two can be classed as within the realm of engineering education. Surprisingly enough, of the several men whose performance at HRB did not justify keeping them on the staff, only one has been let go because of lack of technical knowledge. (Only about five men are involved here, so the figures have no statistical significance.)

Perhaps I should be addressing a group of engineering management specialists, or a group of psychologists, since most of my list of requisites has to do with non-technical factors. However, as we all know, a good basic knowledge of engineering is the *sine qua non* and unless the engineer has it there is no need to discuss the other factors, important though they may be. Before we leave the subject of non-technical factors,

I would like to put in a plug for making the engineering student aware of the importance of these factors in his future work. This need not be done in the classroom but can be accomplished through seminars and other evening sessions where representatives of industry are brought in and asked to tell the student what it is like "on the outside."

A series of such sessions at Penn State, where the seniors in electrical engineering are exposed to a number of outsiders who explain their jobs after being out of school 4 or 5 years, are certainly helpful and should impress on the student that it isn't only skill with a slide rule that counts.

Physicists vs Engineers

Since our company hires almost equal numbers of engineers and physicists, and uses them more or less interchangeably, we have an opportunity to see how they compare when exposed to the same kind of problems. Our work falls generally in the category which the trade calls "systems development"; most jobs are neither pure physics nor pure engineering. You might say that our work is too low-brow for physics, and too impractical for engineering. In any event, a team of engineers and physicists, usually abetted and hampered by a mathematician and sometimes by a psychologist, can normally find an acceptable solution to the problem at hand. In general, both the physicist and the engineer will provide valuable assistance to the project, and in about equal measure. Many of our engineers, however, would be at a loss in deciding how to begin complex analytical projects.

Since most of our physicists have a liberal arts background as opposed to the engineers' more regimented program, it is interesting to consider the effect of this difference on their performance. Our new engineers are usually more ready to do something "constructive" than the new physicists, the engineer being trained for something fairly specific, the physicist being merely trained in a few basic subjects.

The physicist is usually more versatile and more at home regardless of job assignment. Of course, almost all new men need close supervision and their growth during the period of the next 3 or 4 years probably has more to do with their success at our company than their college years. Our experience indicates that the physicist is more likely to develop into a good analyst and a good member of the development team, while the engineer is more likely to be weak on analysis but more aware of project scheduling, budgetary restrictions, and the like.

To determine what differences exist in the educational backgrounds of our physicists and engineers, we have conducted a survey of our employees. The results indicate that the physicists have over twice as many credits in basic science as the engineers.

The principal difference between the performance of our physicists and engineers lies in the field of analysis. Most of our difficulties have stemmed from not doing sufficient analysis before undertaking to build some device. If one device or approach is known to be satisfactory, it is easy to use that design or approach rather than to consider the advantages which might accrue to any of several possible alternatives. For this kind of operation, our physicists' training has stood them in good stead. Hence, I believe that more analysis could be

profitably worked into the engineering curriculum.

Another factor on which our engineers are weak is that of English usage and report writing. A job well done is not appreciated unless it is communicated to others. This involves several communication channels, but the most important in our business is the technical report. Almost all of our engineers demonstrate an aversion to writing a report and an inability to write a good one. Our survey showed that our engineers averaged only 10 credits of English, including short courses in American or English literature. There is apparently not enough emphasis on English usage in the engineering curriculum. I believe this situation is fairly serious and deserves the attention of those who establish engineering curricula. Incidentally, the aversion to writing reports is not limted to our engineers, but applies pretty generally to most of our employees.

To those who say that more time is needed to crowd in the technological details of an ever-expanding world of engineering, I say—let the details go. The student cannot possibly get them all in any case. Let him learn most of these later. Reserve his time for fundamentals such as physics, mathematics, and chemistry, but don't overlook English.

Of our seven or eight men who have had to work with transistors, none had any undergraduate training in the characteristics or use of these devices. They have all acquired their knowledge of transistors through study of published material, through experimentation at our laboratory, and through attendance at short courses offered by Penn State during the summer months. I cite this example only to show that the lack of training in this subject in college has had no bad effects on performance. The college years represent only about 10 per cent of the active professional man's life. It is not necessary to stuff him with enough information to keep him going for a lifetime. When the student enters college it is not so much a question of what he learns during the next four years as it is in what direction he will move for the next 40.

In Short

The proper equipment for an engineering graduate, as seen from my experience with a small research and development firm, is a sound background in the basic sciences, an ability to communicate his ideas to others, and an inquisitive nature which will cause him to remain a student throughout his professional career.

NEW LOWELL COURSE

Lowell Technological Institute, Lowell, Massachusetts, has established a new area of specialization, general engineering. The four-year course which leads to the B.S. degree in General Engineering was inaugurated to train graduates who would cut across the traditional lines of engineering specialization. Lowell Tech will be the first publicly supported college in New England to make such a course available to future engineers. The industries of Massachusetts have evinced great interest in this program and cooperated in its establishment. The new course will be available to incoming freshmen in September, 1956.

TRENDS IN ENGINEERING EDUCATION

The Case for a New Science Background

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A paper presented at the Syracuse meeting of the New York Section ASEE, on October 14, 1955

Three trends that affect all engineers have developed with particular rapidity during the past two decades: (1) the research-mindedness of industry, (2) the highly technical nature of recent wars, and (3) the consequent, or at least concurrent, research-mindedness of engineers. These have had the effect of vastly increasing the technology and experience within the engineering profession. Even more, they have been accompanied by great complexity in engineering projects and activities, to the point of requiring an almost new breed of engineers to cope with the demands of these projects.

This does not mean that there is a single pattern for all engineers, or that engineers trained in the older curricula have lost their usefulness. On the contrary, the number of jobs waiting for such people will be greater than ever before and many schools may quite properly choose to continue to train in that pattern. It does mean, however, that the shift in the spectrum of engineering activities demands that many engineers be trained for the new research functions that engineering now includes.

What are some of the characteristics and functions of the modern engineer? To begin with, he is more schooled, with more advanced degrees, than was the earlier custom; the doctorate is almost a prerequisite to responsible work in several of the engineering divisions. He is required to be fairly versed in mathematical methods, and does not hesitate to take courses of study that once were the domain of the physicist and mathematician.

His interests and problems have gone far beyond the limits of handbook technology. He has even had to give up his complete dependence on the pure mathematician and physicist for analytic techniques, since these people are too engrossed with their own advances to be of much help on engineering problems that are burdened with realistic details. Complex electrical and mechanical computational gadgetry have become his domain also.

As a consequence of all this, a remarkable blending appears to have taken place between engineering and the pure sciences. Just as physicists, chemists, and mathematicians of a few decades ago found that their research interests over-lapped when they got down to business on the atom, so now it often becomes difficult to determine from the subject matter and the treatment whether a piece of research should be conducted by a "pure" scientist or by an engineer. It has been repeatedly noted by educators that basic problems and basic

techniques of pursuit are becoming common to more and more disciplines, whether solid state research, high frequency electrical phenomena, aerodynamics, mechanical, or nuclear systems.

Perhaps the most dramatic example of this blending and extension of perspective has developed in connection with nuclear power. The role that engineers-turned-scientists have played in this development has not been sufficiently emphasized. Many of the basic concepts and techniques connected with gaseous diffusion plants and early nuclear reactor systems were developed by engineers.

Moreover, the engineer is gaining firm footing in this remarkable field. There is now much less dependence on the physicist and chemist to design the plants and components, or even to undertake research that will lead to improved reactor concepts and to improvement in the subtleties of reactor economics.

This points strongly toward a different type of training for engineers. Indeed I am of the opinion that the nuclear power program will be the greatest single factor in setting the pace and pattern of advanced engineering education for the next few decades, to a degree that goes far beyond the actual percentage of engineers engaged on nuclear work. This will be true partly because of the needs of the atomic program, but even more because the improved teaching and engineering concepts and techniques that accompany the nuclear program will in time supplant many of the less-cogent current methods.

The blending of interests and techniques has scarcely made itself felt in college catalogues, however, where one finds impressive duplications among such courses as thermodynamics, mechanics, fluid dynamics, structural analysis, and vibration. Engineering instructors seem scarcely to have found any common principles to influence their teaching; at least it seems much easier for a department to add its own new course than for several departments to join hands in cultivating common ground.

I do not know how this condition can be helped. The nuclear power program could improve the correlation and unification among the disciplines, unless we prevent this by setting up separated departments for nuclear engineering also. At R.P.I. we are pursuing nuclear engineering on the assumption that all the engineering and science divisions must contribute to the development of atomic energy, each with the emphasis corresponding to its research and educational interest in this broad field.

Weakness of Undergraduate Training

While specific engineering subjects can stand some further analysis, I would prefer to spend this time on the science background courses, namely physics, chemistry, and mathematics, which are offered to engineers. The controversy has been warm on the subject of the teaching of these subjects to engineers, with opinions running all the way from satisfaction with courses as they are now taught, to suggestions that engineers take over most of the job. Physicists themselves, under the sponsorship of the American Institute of Physics, have seriously studied the problem, and a report on the Role of Physics in Engineering Education has appeared. (*Editorial note: for the final version of*

the AIP report, see the March issue of the JOURNAL.)

While this Report contains good recommendations for improving the teaching of physics, I am not certain it adds the new approach that is called for. My own degrees were taken in physics and I am sympathetic to that approach, but I must nevertheless join with those who ask for a more effective presentation of physics to engineering students. However, I would not suggest that others take up the teaching job of the physicist, any more than non-chemists should teach chemistry.

The Report of the American Institute of Physics suggests that the most important contribution that physics can make to the training of engineers is to provide a knowledge and appreciation for (1) the methods that have been found effective in describing the way nature behaves, and (2) the concepts that have been derived therefrom. I am inclined to think that objectives stated in these words tend to encourage, rather than discourage, encyclopedic and historic details that submerge rather than reveal the fundamental laws of nature to those who are not physicists. Except as these concepts are recognized by the student to be the underlying and *unifying* principles on which the current engineering techniques find firm base, physics will not have done its work.

But therein lies the rub. The basis for engineering is not revealed by improvements in the teaching of physics alone, nor in the teaching of chemistry alone, nor in the teaching of mathematics alone. Actually a new science background is needed for engineers, in the form of a closely integrated combination of all three disciplines.

But, you say, we have just these ingredients in our undergraduate curriculum. We do, but they are far from making up an integrated unit. Instead, they are more often three separate courses, each of which proceeds on its way with little appreciation either for the new role that engineering has assumed, or even for the close research ties that these three sciences have enjoyed amongst themselves for the past several decades. Their concentration on the details and logic and self-consistency of their own views or courses appears to have sacrificed much of the unified, integrated value that more concerted effort might have developed for the appreciation of nature's laws and for more scientific engineering application. The chemist teaches about the atom in considerable detail, and the physicist also manages to get to the atom. From their different treatment of the subject, however, an engineering student would scarcely find assurance that these atoms are the same one, constituting the stuff that makes up the core of his whole technical life.

I submit, therefore, that the most urgent and important need in our undergraduate engineering curriculum is for a more effective science package, which I hereby propose.

A New Science Package

While the development of the characteristics of this science package should be a project for a whole group of scientists and engineers, I should like to hazard a few suggestions, nevertheless. (The term "package" is applied here to emphasize the unity of objectives, rather than to imply a single course or one type of teacher.)

To begin with, the *material of this "package" should continue to be*

taught by mathematicians, chemists, and physicists, probably still as parallel courses. There would be joint effort, however, to introduce the subjects in such coordination that the three would support each other all through the two years that such a package might require. That is, when mathematical concepts are introduced, they should, whenever possible, seek to fuse into the physics subject then being taught, both to support the physicist and to be supported by his physical concepts. Similarly the chemist should introduce his concepts so as to derive maximum support from, and give maximum support to, the mathematician and physicist.

But these are the mechanical aspects of the package; the meat of the new approach must lie in the substance and particularly in the end objectives. What, then, might be the aims of this science package?

1. To develop, and to demonstrate, the concepts and basic techniques that underlie science and engineering, through the medium of chemistry, mathematics, and physics.
2. To provide the student with the techniques for extension of these concepts into engineering subjects.
3. To imbue the student with the spirit of investigation that will continue into his engineering practice.

These objectives clearly envision the three current science disciplines as handmaidens for the understanding of natural phenomena rather than as ends in themselves.

First, then, there are needed clear statements as to what are the important concepts of natural phenomena. Conservation laws and conversion of energy, so important in mechanical heat, electrical, and chemical systems, could provide one central theme for a broad theoretical and experimental attack from several sides.

The atom, which the physicist has treated as an afterthought even in two-year physics courses, will have to be given a fairly central place. The physicist will want to unfold some of the marvels of atomic structure and at least touch on the quantum theory in order to dispel any notion that physics and mathematics are logical in the usual sense. The chemist would add his concepts and techniques for the forces that govern chemical behavior of atoms and molecules, and try to correlate them with the physicist's forces. Together they would delve into the science of the solid state, the gaseous state, atoms in violent motion, and properties of the liquid state.

Meanwhile the mathematician would struggle to get as rapidly as possible up to the point where he could attempt differential and integral calculus. If he were clever enough, he might be ready to analyze harmonic systems and some of the electron dynamics at just about the time the physicist introduces these subjects. (Let me note in passing that it would be unfortunate for the electrical engineer to attempt the study of electric currents without first having studied the electron in motion.)

After these and other central themes had been developed, and the way suggested for extension of these into engineering application, there would perhaps be time for some of the details and memory work that now crowd these courses. Or, better still, these details could be taken in stride by the engineering courses, along the lines set out by the ASEE Report on Evaluation of Engineering Education.

It is possible that this material

should be extended over more than two years, perhaps including one required course in the junior or senior year to help correlate with engineering techniques. Even with extension into the third year, it is unlikely that the time consumed for this study would exceed the total time now used.

The principal obstacle to undertaking such a program is lack of textbooks directed to these objectives. I am persuaded that there is interest enough to overcome this obstacle; however, I urge that the movement be started.

Engineering and Cultural Courses

One of the objectives proposed for the Science Package was that the student be helped to continue his spirit of investigation into the engineering subjects. Actually there should be pressure applied to carry the whole Science Package approach into the engineering area also. It seems fruitful to do this, particularly as engineering courses are developed to be mathematically analytical rather than prolonged exercises in hardware design. A certain amount of hardware experience is certainly needed to assure that a graduate is not altogether lost on his first job, but his promotion to advanced engineering is likely to be prejudiced if hardware training has been given preference over more basic engineering knowledge.

Under Engineering Sciences, the Report of the ASEE lists (1) Statics, (2) Dynamics, (3) Strength of Materials, (4) Fluid Mechanics, (5) Thermodynamics, (6) Electrical Circuits, Fields and Electronics, (7) Heat Transfer, (8) Engineering Materials, and (9) Physical Metallurgy. It does seem that under these headings a good many new courses could be developed that are basic and common to more than one department.

A word about the so-called cultural or general studies courses. The Interim Report, with many others, has stressed the importance of including more such courses in the curriculum. Their case is fortunately becoming stronger and stronger. There is a suspicion, however, that the efforts have been more fruitful in the direction of increasing total hours devoted to these subjects than in gaining clearer understanding and definition of objectives or of what should be taught under this heading. But time and continued study will resolve these difficulties also.

Research; Its Importance and Hazards

It seems clear, in short, that research-mindedness is the new way of life for many engineers. By the same token, participation in research is becoming more and more necessary on the part of engineering educators. Training for leadership is more a matter of example and the right attitude and inspiration than it is of quantity of detail swallowed, and the demand is increasing for teachers who inspire this spirit of investigation. By and large, this spirit is best felt and promoted by teachers who themselves are also engaged in "frontier pushing" through advanced research; it seems necessary, therefore, that the spirit and practice of research become important in the life of the engineering campus.

Sponsored research entered the college campus on a grand scale during the Second World War, and has continued to grow. The effect of this has been mixed because so many of the technical programs were addressed to very specific objectives which lacked scientific interest. Nevertheless, many

basic research programs were started by these sponsoring agencies. Schools obtained equipment and experience, and had it not been for these sponsored programs it is likely that colleges would have lagged even more seriously behind the advance of engineering practice.

What of the future of research in colleges and of sponsoring groups? Engineering colleges will have to participate much more actively in research than their own budgets will permit. Sponsored research will have to help pay this bill, and also help colleges to attract capable men whose salaries can be divided between the teaching budget and the research budget.

It also seems clear that attention must be focused on the nature of research programs that ought to be entertained for colleges, as well as the method of sponsorship. A cardinal rule should make research a significant and integrated part of the educational program; research that is noncontributing to engineering technology should be avoided or be separated from the teaching faculty. Each man should work only on programs in which he has personal interest, and of course should exercise initiative to develop such programs.

But who, you ask, would support such research? Fortunately the government agencies and foundations support a great many such fundamental programs. But the base of sponsorship should be broadened to include much more industrial support than has been the case thus far. Industry makes heavy demands for graduates of all types, with emphasis on graduates who have been active in research. But there has been less inclination to support the schools and the research programs that make this training possible. A major shift must call for industrial support of research programs at colleges on terms favorable to the educational needs of the schools. That is, the monies cannot be tied with too many strings, nor the programs defined by narrow-minded individuals who seek quick returns to the sponsoring company.

The responsibility for helping industry to understand this need for support, the types of programs to be undertaken, and the proper terms for implementing grants and contracts, must lie with the individual faculty members, with the school administrators, and particularly with the research contract officers. Fortunately the more forward-looking companies have already sensed both the problem and the hazards, and are willing to cooperate.

Summary

In summary, the trend toward blending scientific activities with engineering continues strong. This calls for support both through proper research activities as a normal part of engineering educational activities, and by a dramatic improvement in the fundamental and engineering science background offered to engineering undergraduates. A science package and its objectives have been proposed, in which chemistry, physics, and mathematics play a more integrated and effective role in strengthening the preparation of engineers for their new, more responsible engineering functions in a more complex engineering world.

OPERATION COOPERATION

W. E. HOWLAND

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A condensation of a paper presented at a Panel Discussion on "Improving the Social-humanistic Stem of Engineering Education through Inter-departmental Cooperation," at a meeting of the Indiana-Illinois Section of the ASEE, Notre Dame University, May 21, 1955.

Surely cooperation rather than antagonism is the method and attitude that should be adopted to accomplish the goals of all the stems and branches and vital twigs of engineering education: whole-hearted and informed encouragement and support of one field of instruction by the teachers of another. Cooperation would be easy if we could all agree with the faculty of Yale University that what is most needed now is an intensification of the intellectual life of the campus. As an example of such cooperation, at Purdue we have had for sometime an enterprise called the Inter-Curriculum Colloquium.

The general purpose of the colloquium is simply to exchange ideas across the academic fences between engineering and social sciences or liberal arts. Discussion leaders have ranged from a philosopher of science to a political scientist. Our English Department has stimulated us with its "Books and Coffee" programs, which we attend by the hundreds. Another venture is the Matchette Foundation lectures which are given by distinguished visiting philosophers. The afternoon symposia in most of the engineering schools have crossed academic boundaries at a very high level. We engineers have heard neuro-physiologists and sociologists, as well as experts in information theory and operations research.

It is the vogue now to emphasize the disagreements and paradoxes and inconsistencies of our ideology. Yet to me the agreements, at least among university teachers, are vastly more impressive. Surely we are all using the same logic and essentially the same methods of deductive and inductive reasoning.

The scientist habitually ascribes a degree of error or improbability to his assumptions and hence also to his conclusions, reminding him to be on the outlook for needed correction; the devotees of certitude, on the other hand, express their humility in a different way. Yet all claim to use the same logic.

What Is Beauty, for Example?

Perhaps there is one value upon which disagreements are now impressive, and that is the value of beauty. In science and engineering it still has a clear and conventional meaning. It is order, balance, harmony; unity, coherence and emphasis; recognizable

uniformity of principles among intricate phenomena, splendor of pattern, as in crystal structure and in the equations that describe it, and fitness of form to function as displayed by a Golden Gate Bridge. The disorder that remains, the perplexity of problems still unsolved, only accentuate the beauty of the order that has been discovered and achieved.

Formerly one was taught to believe that beauty in a similar sense was the goal of the artist, and that a like beauty of character was the passion of the preacher. But lately it appears that the typical modern artist, in abandoning his skills and discipline, has gone all out for disharmony, dissonance, incongruity, the abomination of desolation, the terrible mistakes of nature and the monstrosities of disordered imaginations. Theologians like Reinhold Niebuhr, poets like T. S. Eliot, novelists such as Graham Greene and writers like John Steinbeck and Tennessee Williams have chosen to emphasize the dissonance, the violence, the sin and depravity of natural man.

Science Brings Sanity

Undoubtedly this view should be presented to the students as a factual account of an ancient, recurrent, and now again an influential modern trend. To me it represents a masochistic retreat from the reasonableness of the universe in all its complexity—the view that science increasingly reveals and technology is constantly exploiting for the practical service of man. One of the surest modern roads to sanity is work in science and in applied science like engineering!

But note that I am criticizing what I believe to be a modern and momentary trend in art, music, and theology. I do not despair. Our humanistic program may still be magnificent, for we have the powerful tradition of Michelangelo, Mozart, Shakespeare, Dickens, and Mark Twain. We have the reasonableness, in their different ways, of Aquinas, Descartes, Spinoza, Pascal, William Ellery Channing, C. S. Pierce, and A. N. Whitehead to support us now when all but scientific eyes seem to be focused on madness.

Summed up, these are my ideas:

1. Academic cooperation is important for promoting education in the basic, old-fashioned sense.
2. The pace of campus intellectual activities needs to be stepped up.
3. The academic community is dependent upon the philosophers, poets, literary critics for criticism of values and goals of the University, and for helping us to reach agreement upon them.
4. Tradition must be given its proper role. In science we study our tradition; we question, criticize, and correct it, but build upon it. This is progress. In art we stupidly but willfully reject tradition. And this brings chaos.

EDITORIAL STATEMENT

Perhaps to evolve sound JOURNAL policy we need only point to the increasing importance, complexity, and central responsibility of the Society in the decade or so immediately ahead. As never before, engineering education can afford only the best thought on what should be taught for the finest professional education possible. Equally important are the various ways of accomplishing the proper ends once defined, and the means of finding and employing the staff, techniques, and physical facilities required for the task. Teaching and education in this context, of course, imply at once academic research and administration—the other faces of the instructional-educational problem.

With many societies and associations concerned on the one hand with purely technical advances in engineering arts and sciences, and with other professional organizations concentrating on the serious problems of engineering practice, the ASEE stands strategically in a position to link these groups. As the academic focus and contact point, the Society and the JOURNAL can well serve as a correlating and coordinating force, as a means of exchanging ideas among groups, of keeping our thinking up-to-date and advanced.

In practice this probably means that the emphasis of our limited space should be placed primarily on teaching, learning, and all of their implications, including the educational functions (both undergraduate and graduate) of laboratories, research, and industrial experience, problems of adjustment, plus preparation for and development in professional practice.

Thus theoretical or highly technical essays on thermodynamics, mechanics or electrical phenomena might well go to the recognized journals in their respective fields, unless some adaptation or application were evident, either directly to students or as helps for instructors. The criterion for publication, then, would be excellence in or contribution to educational thinking, insight, knowledge, or technique.

In judging this utility, however, the JOURNAL's function of general service to the Society must also be considered. Divisional or Sectional recommendations should be taken seriously, on the ground that so long as space is available the Divisions themselves are in a position to know what is of value to them—especially if they keep in mind the interests of the several thousand members in other divisions.

It appears that fall issues might well concentrate on summaries of papers from the previous annual meeting. Spring issues might emphasize original contributions defining problems for consideration at the forthcoming annual meeting, plus papers from the winter Divisional and Section sessions. Thus articles would be considered equally on a recommended and voluntary basis.

Balance would still have to be maintained geographically, in terms of size or type of institution, and in point of view, even though occasional ideas were expressed which did not represent the majority or universal thought. There should be room in

the JOURNAL for discussion comments, and for differences of opinion leading to profitable sessions at Annual or earlier meetings.

At the moment this balance is heavily affected by the initial emptiness of the manuscript cupboard (for a time it seemed that writing had gone out of fashion in the ASEE, though this is being rapidly rectified), and by the apparently higher productivity of the semi-humanistic groups (including guidance, psychology, and economics) in contrast to the technical branches. This may also reflect the influences of the Evaluation Report and the Social-Humanistic study. The major immediate exception is the Mechanics Division, which has discontinued its own publication, and so is better supplied with contributions (even after deduction of the highly specialized papers) than the other fields.

The answer to balance is, therefore, rounded production of papers designed for publication. Differentiation by authors between what *sounds* well as a talk and what *reads* well in print would be of great help to the JOURNAL, especially in achieving compactness, concentration of ideas, and economy of space. If stylistic assistance is desired in revising or preparing technical papers for the JOURNAL, the English Division has kindly offered the services of its members, on a local or sectional basis, for consultation with prospective authors from the other Divisions of the Society.

A much-neglected consideration of planning ahead in *time* needs to be noted, too. Under the *two-month* minimum production schedule imposed by the Lancaster Press for each issue of the JOURNAL, material should be received by the JOURNAL at least *three months* in advance of the expected publication date if issues are to be available early, as they should be. In the past, Society members have interpreted as weeks what need to be months, and the expected results have followed.

Last-minute brief items can of course be inserted in galley or page proof not later than one month before publication date, but such entries must be clear, complete, and accurate, requiring no correspondence, further approval, or negotiation.

(Immediately, such elementary considerations as sending in manuscripts typed with six inch column width (72 characters per line), double spaced, on one side of the page, and with a carbon copy or two, would be of great help. Content-wise, brief statements of introduction (purpose) and of conclusions (significance or summary) would add greatly to the effectiveness of most manuscripts received.) For the future, it is hoped that a brief style sheet or booklet can be prepared, that some help can be given by the JOURNAL staff in preparing printable illustrations, and that reasonably prompt reactions will be possible to outlines or abstracts of proposed papers if such service is requested by members.

The experimental revisions of type size, style, and format (unfortunately limited somewhat by those economically available at the Press) have had the same intentions—to increase readability and ease of reference for Society members without undue loss of space or content. Considerable economy in printing and cost has been obtained at the same time. If the Society feels them to be desirable, further changes will be explored, as the initial ones by the Publications were,

and the Editorial Committees. Suggestions will be welcome, both as to appropriate content and form, including such matters as the tentative publication schedules set forth below.

With the cooperation of Divisions, Sections, and members, it is hoped that the JOURNAL can continue and perhaps improve its fine record of publishing dignified but significant articles and information in a unique field of steadily increasing interest and importance.

The arrangement of the academic year suggests a variable publication schedule, if that can be met, possibly on the lines suggested below. Does this appeal to Society members?

Reports of Annual Meeting	September 20–30
Papers from Annual Meeting	October 10
Papers, continued	November 1
Papers, concluded	December 1
Original articles, annual meeting forecasts	January 10–15
Yearbook and enrollments	February 1
Original articles, special-topic issues	March 1 April 1 May 1 June 1

MICHIGAN PROGRAMS

The University of Michigan will again hold the two summer programs, the Workshop for College Professors and the Institute on College Administration. Its fourth annual Workshop for College Professors, June 25 to July 13, will include presentations by a special workshop staff, discussions, and projects related to individual member's needs. The Workshop will be followed by an Institute on College Administration, July 16 to 20. Such problems as the administration of the curriculum, personnel and finance will be discussed by resource leaders, with special attention to institutional self-studies and to the human relations factor in personnel administration; also an opportunity will be provided for individuals to study problems or topics of special interest to them. Additional information may be obtained by writing to the Director, Algo D. Henderson, 2442 U. E. S., University of Michigan, Ann Arbor, Michigan.

. . . . . YET-ITUDES

VIEWS AND NEWS CONTRIBUTED BY

The Young Engineering Teachers

JOHN L. ARTLEY, Chairman
Duke University

HAROLD A. FOECKE, Editor
University of Notre Dame

YOU CAN'T DO IT ALL AT ONCE

ROBERT T. HOWE

Professor of Civil Engineering
University of Cincinnati, Cincinnati

How many times have you read of the various characteristics desirable in an engineering educator, and wondered how you could ever live long enough to acquire all of the traits specified?

Or do you find that you have trouble carrying on a research project while teaching a full schedule, taking a graduate course or two, and writing a book in the evening after the children have been tucked into bed?

If you are troubled by these or similar maladies, this writer says: "Relax! You can't do it all at once! Even Rome wasn't built in a day!"

Under the subheading "Evaluation of a Faculty," the final *Report of The Committee on Evaluation of Engineering Education* lists six qualifications which should be used as criteria for selecting new teachers. It would be difficult to set up a more comprehensive set of qualifications—and still more difficult to find a young man interested in becoming an engineering educator who possessed even a majority of these attributes!

But, in the same way, it would be difficult to find a one-year-old child who could speak well, had good table manners, never quarrelled with other children, and amused himself by reading "The Great Books." In other words, a growth process is required. When a man begins teaching at 22 or 25 years of age, he can hardly be a fully developed teacher. Also, it is difficult for anyone to say how his growth will take place, for not even he is fully aware of how his interests will develop.

While no one can tell just how an engineering instructor's growth will take place, his Dean and Department Head certainly have the right to expect that there will *be* growth, and that it will be in directions recognized as desirable in engineering education.

Because an engineering educator must play a dual role as teacher and professional practitioner, growth must be along both these lines. In the writer's opinion, teaching should be given precedence during the earliest years, for bad or dull pedagogical

habits developed during the first few years may never be broken. It is recognized that very few teachers of engineering have ever "darkened the doorway" of a Teachers College, but there are many books available on the learning processes, and the JOURNAL OF ENGINEERING EDUCATION has carried numerous helpful articles on teaching methods. Teaching is, however, a practical as well as a theoretical art—one which must be acquired slowly with liberal applications of patience and conscientious effort.

An age-old maxim is "The teacher must always learn more than his pupils." This is another reason for concentrating on teaching during the first few years, for the young instructor must spend considerable time in study, preparing for each class. In certain fields, this preparation is so difficult that the new teacher may be required to have a doctorate before he is engaged. Regardless of his previous academic preparation, however, considerable thought must still be put into preparing for each classroom period.

Early interest in the professional societies actively concerned with his teaching field is important to the beginning teacher. While it may not be possible for him to attend national meetings during the first few years, he should certainly make every effort to participate in local ones. Almost every professional publication invites discussion of the articles and papers it prints, and the young teacher should gradually make plans to take part in this activity. His early observations may or may not be printed, and may or may not be valid, but the study necessary for the preparation of such discussions is invaluable. A graduate course or two may be carried each year during this early period, but, again, teaching should be given priority in time.

Outside Activities

After two or three years of classroom experience, the young teacher should be in a position to engage in some outside activity. This might be committee work in professional organizations at the local level, independent or sponsored research, or perhaps some elementary consulting. Please note the "or's"—"You can't do it all at once."

Money received from outside activities can be profitably used for travel to national meetings of professional societies, including ASEE. When, through attendance and active participation in the open meetings, one becomes known by various leaders of such organizations, he will be asked to serve on one or more of the responsible society committees. Such service offers invaluable experience of a forward-looking kind.

A word of caution is appropriate concerning consulting work. The final *Report of The Committee on Evaluation of Engineering Education* states: ". . . the belief is widely accepted that an average of one day per week of the individual teacher's time devoted to consulting activities of a high professional character will reflect to the overall advantage of the institution." It will be noted that the emphasis is placed on "high grade," but the young teacher must often be content with less important arrangements. These less important jobs, however, especially those of routine nature, should not be given too much time merely "for the extra money."

As the young educator progresses with his teaching and professional activities, he will eventually find some topic of particular interest to him in

science, engineering, education, or even administration. To satisfy his desire for additional knowledge in this area, he may undertake a research project on his own initiative, or may decide on additional formal study which may or may not lead to a doctorate. This latter tack is one which the young teacher may not think of, but today a very considerable number of engineering faculty members in their "thirties" are returning to school for further study. There are many financial aids available, even for men with families. These include not only special grants for concentrated study, but also teaching and research assistantships which make possible simultaneous gains in apprenticeship time and experience.

As the enginering instructor pursues his quest for knowledge in a particular field of interest, he will eventually become recognized as an authority in that field. Such recognition will probably bring with it more opportunities for consulting work at a constantly higher professional (and remunerative) level. In addition, the research may lead to the writing of a monograph or book.

Human experience indicates that one interested solely in his own personal welfare and "getting ahead" is not likely to achieve true "success." The man who would lead must be willing to go "the second mile." Church and civic activities also need intelligent, dynamic volunteers, and engineers have a point of view which is most helpful to such organizations. But again "You can't do it all at once"; in becoming a teacher, the engineer must not overlook development of himself as a person, and must not neglect his family or his other human relationships. He owes scholarship and living an equal duty.

Just as the rate of physical and mental growth varies from child to child, so the rate of professional growth varies with individuals, but most engineering teachers will be approaching 40 years of age before they achieve professional maturity. Perhaps this is why the George Westinghouse Award for outstanding teaching is awarded to "young" teachers not over 45 years of age, and why so many recipients have been pushing this boundary age.

It would be folly to say that by following a definite formula any one of us could win the Westinghouse Award; if this were so, the Award would lose much of its significance. But whether he wins the Westinghouse Award or not, every young teacher of engineering students can become recognized as an engineering educator of stature if he will (1) decide that this is what he really wants to be, (2) accept every opportunity to grow professionally and personally, and (3) relax, for he can't do it all at once!

COOPER MADE CHAIRMAN

Dr. Albert H. Cooper, a member of the ASEE since 1939, has succeeded Professor Richard F. Shaffer, a member since 1948, as Chairman of the Department of Chemical Engineering at Pratt Institute, Brooklyn, New York. Dr. Cooper has also replaced Dr. Shaffer as the Pratt representative on the Engineering College Research Council.

THE T-SQUARE PAGE

Sponsored by the Division of Engineering Drawing

W. E. STREET, Chairman
I. L. HILL, Vice-Chairman
H. P. SKAMSER, Secretary-Treasurer
R. S. PAFFENBARGER, Member of Council

Editor: ALBERT JORGENSEN, University of Pennsylvania

Chairman's Message

WILLIAM E. STREET
Chairman, Division of Engineering Drawing

The activities of the Division are progressing along numerous fronts as indicated by the number and diversity of the committees which are listed together with personnel in this report. The whole-hearted cooperation evidenced by members in accepting assignments and in performing committee tasks is very gratifying.

The Report on Evaluation of Engineering Education, 1952–1955, recognizes our field and defines our objectives in the following paragraph:

"Graphical expression is both a form of communication and a means for analysis and synthesis. The extent to which it is successful for these purposes is a measure of its professional usefulness. Its value as a skill alone does not justify its inclusion in a curriculum. The emphasis should be on spatial visualization, experience in creative thinking, and the ability to convey ideas, especially by free-hand sketching, which is the normal mode of expression in the initial stages of creative work. Though the Engineer may only supervise the preparation of the drawings required to execute his designs, he can hardly be expected to do this effectively unless he himself is thoroughly familiar with graphical communication." Let us not take these responsibilities lightly.

As a Division we are taking them seriously, not only with the Midwinter Meeting in Chicago on January 27–28, but with our 1956 Summer School in Engineering Drawing. This will be held in conjunction with the Annual Meeting of the Society at Iowa State College. We will begin Summer School sessions on Wednesday, June 20, the week before the Annual Meeting. Drawing Division events will then continue through Tuesday, June 26, featuring a joint conference with the English Division, and Wednesday, June 27, a joint conference with the Mathematics Division.

Theme of the School will be the "Evaluation of Engineering Drawing for the Future." This will be carried out by discussions of modern objectives for drawing and engineering geometry, means of correlation with the other sciences, the aspects of graphic science which accord with the ASEE "Evaluation Report on Engineering Education," and the development of creative and imaginative problems for engineering drawing courses.

This should be a banner year for the Engineering Drawing Division. How about setting some new attendance records?

Committees of the Engineering Drawing Division

EXECUTIVE COMMITTEE: W. E. Street (chairman), T. T. Aakhus, E. M. Griswold, I. L. Hill, R. P. Hoelscher, H. B. Howe, A. Jorgensen, R. S. Paffenbarger, J. H. Porsch, James S. Rising, H. P. Skamser, C. H. Springer, C. J. Vierck, I. Wladaver.

PUBLICATION COMMITTEE, JOURNAL OF ENGINEERING DRAWING: E. M. Griswold, H. B. Howe, I. Wladaver.

SPECIAL AWARDS COMMITTEE: J. J. Gerardi (chairman), T. T. Aakhus, R. T. Northrup.

ADVANCED GRAPHICS COMMITTEE: F. A. Heacock (chairman), J. N. Arnold, C. H. Kearns Jr., A. S. Levens, J. G. McGuire, J. T. Rule.

BIBLIOGRAPHY COMMITTEE: S. E. Shapiro (chairman), M. L. Betterly, L. C. Christianson, R. E. Lewis, A. S. Palmerlee.

TEACHING AIDS COMMITTEE: Justus Rising (chairman), M. W. Armfeldt, W. M. Christman, I. L. Hill, E. W. Jacunski, J. D. McFarland, R. S. Paffenbarger, J. E. Pearson, H. P. Skamser, F. H. Smith, O. M. Stone.

POLICY COMMITTEE: C. H. Springer (chairman), T. T. Aakhus, J. J. Gerardi, R. P. Hoelscher, Justus Rising.

ELECTIONS COMMITTEE: I. L. Hill (chairman), C. I. Carlson, M. B. Lagaard.

NOMOGRAPHY COMMITTEE: D. P. Adams (chairman), J. N. Arnold, D. S. Davis, F. H. Heacock, C. H. Kearns Jr., R. A. Kliphardt, A. S. Levens.

COMMITTEE ON DISPLAY OF STUDENT WORK: M. W. Armfeldt (chairman), E. H. Brock, J. S. Dobrovolny, M. McNeary, F. C. Morris, B. F. K. Mullins, E. G. Pare, L. E. Young.

COMMITTEE ON INSTRUMENTS AND MATERIALS: L. R. Schruben (chairman), C. A. Arnbal, F. Binns, M. F. Blade, H. G. Kinner, C. C. Perryman, P. O. Potts, L. M. Sahag, R. R. Worsencroft.

COMMITTEE ON DISPLAY OF INSTRUMENTS: C. A. Arnbal (chairman), R. M. Coleman, A. Jackson, C. A. Newton, J. E. Pearson, N. D. Thomas.

COMMITTEE ON TESTS: F. C. Bragg (chairman), L. O. Johnson, P. E. Machovina, J. M. Russ, H. C. Spencer, H. C. Thompson Jr., E. C. Willey.

COMMITTEE ON REPRODUCTION PROCESSES: S. M. Cleland (chairman), D. P. Dixon, R. L. Paul, D. N. Pierce, G. Rook.

NOMINATING COMMITTEE: C. H. Springer (chairman), F. C. Bragg, J. J. Gerardi, A. P. McDonald, R. T. Northrup.

GARRELTS RECEIVES AWARD

Jewell M. Garrelts, Renwick Professor of Civil Engineering at Columbia University, and a member of the ASEE since 1935, recently received the "Great Teacher Award" of the University's Society for Older Graduates. The Society is composed of Columbia College and School of Engineering alumni who received their degrees at least thirty years ago and have continued to give service to the University. Professor Garrelts received his Master of Science degree at the University in 1933. A noted bridge engineer, he designed the Rainbow Bridge over the Niagara Falls.

COLLEGE NOTES

Dr. Donald F. Othmer, professor and head of the Department of Chemical Engineering at the Polytechnic Institute of Brooklyn and a member of the ASEE since 1937, has been elected a director of the American Institute of Chemical Engineers for a three-year term.

The Automotive Safety Foundation has offered the University of California three fellowships for the graduate study of highway engineering in 1956–57. One, at $3,000, is open to a college instructor in highway transportation engineering who already holds a master's degree. Two fellowships, at $2,000 each, are open to engineering graduates who have had highway engineering experience. Applications will be closed February 15, 1956. Those interested should write immediately to the Institute of Transportation and Traffic Engineering, University of California, Berkeley 4.

Dr. Martin A. Mason, a member of ASEE since 1951 and Dean of George Washington University School of Engineering, has been appointed Chairman of the Committee on Research of the American Society of Civil Engineering. The Committee's functions are to coordinate the research activities of the Society, review research progress, and pass upon expenditures from the Society's research funds.

Purdue University's School of Civil Engineering and Graduate School have announced the availability of approximately twenty-two graduate fellowships for the summer session, June 11 to August 4, 1956. These fellowships carry a stipend of $700 each, and are made possible by a free grant from the Asphalt Institute. The grants are open to Civil Engineering teachers or research personnel who are qualified for the study of, and are interested in, the technology and construction of asphalt and other flexible pavements. Requests for information, and applications, should be addressed to Professor K. B. Woods, Head, School of Civil Engineering, Purdue University, Lafayette, Indiana.

IN THE NEWS

The Brazilian government has recently conferred upon D. B. Steinman, a member of the ASEE since 1910 and an internationally known bridge engineer of New York City, the Marechal Caetano de Faria Medal in recognition of his professional achievements and his engineering contributions to the Republic of Brazil. In 1924–27, Dr. Steinman designed and built the Florianopolis Bridge over the waters of the Atlantic between the island-city of Florianopolis and the mainland of Brazil. This bridge is still a major South American bridge and is the longest eyebar suspension span in the world.

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Carl W. Muhlenbruch, a member of the ASEE since 1943, has been appointed to the Training Committee of Engineers' Council for Professional Development. The Council is currently engaged in developing a plan of recommended professional growth for young engineers. Mr. Muhlenbruch will supervise the program in the Chicago area.

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An annual award of $250 has been established by Henry and Ida Schuman of New York City for an original prize essay in the history of science and its cultural influences. The topic should be broadly interpreted, and papers should be approximately 5000 words in length. This competition is open to undergraduates and graduates in American and Canadian colleges, universities, or institutes of technology. Papers should be sent to the Chairman of the Schuman Prize Committee, Professor C. Gillispie, History Department, Princeton University, Princeton, New Jersey. To be eligible for consideration, papers must be received on or before June 1, 1956.

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At the recent fall meeting of the Middle Atlantic Section of the ASEE held at New York University, on December 3, 1955, the theme was the future course of enginering education. The conference delegates discussed means of incorporating more basic studies, principally in physics and mathematics, into engineering programs. This would require a reduction in the number of courses in the highly specialized sub-divisions of engineering.

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The Operations Research Group of the Case Institute of Technology, Cleveland, Ohio, plans a three day conference February 1, 2, and 3, 1956 to bring together a panel of experts who will present

five case studies, each representing a different type and phase of business. In addition to the formal sessions, small groups will meet with the conference staff to explore the case studies presented by the speakers. Further information can be obtained from the Operations Research Group, Department of Engineering Administration, Case Institute of Technology.

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In cooperation with the California Institute of Technology and the Massachusetts Institute of Technology, the Ramo-Wooldridge Corporation has announced fellowships in Systems Engineering for the academic year 1956–57. The program covers a twelve month period, and will provide the recipient with an opportunity to pursue a broad course of fundamental study as well as an opportunity to associate and work with successful engineers and physicists in the field of Systems Engineering. Any American citizen is eligible whose qualifications will admit him either to the California Institute of Technology or the Massachusetts Institute of Technology Graduate Schools, and who has completed one year of graduate study in mathematics, engineering or science, before the beginning date of the Fellowships. Application forms can be obtained by writing the Ramo-Wooldridge Corporation, the Ramo-Wooldridge Fellowship Committee, 8820 Bellanca Avenue, Los Angeles 45, California.

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E. W. Carlton, professor of structural engineering, Chairman of the Civil Engineering Department, and a member of the ASEE since 1949, will supervise an $11,500 grant recently awarded the University of Missouri School of Mines and Metallurgy by the Missouri State Highway Commission and the U. S. Bureau of Public Roads. The fund will be used to finance a study of the effects of prestressing upon thin concrete pavement slabs.

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The University of Maryland on December 5 and 6 held a two-day research conference dealing with fluid dynamics, especially problems of transition and the origins of turbulence. The purpose of the program was to present, discuss, and appraise recent significant advances in the field of theoretical and experimental research in reducing friction and resistance and thus increasing the range of airplanes and missiles. Papers were contributed by scientists from the National Advisory Committee for Aeronautics, the National Bureau of Standards, and other government agencies, by American and foreign university professors, and by representatives of industry.

TEACHING POSITIONS AVAILABLE

ASSISTANT PROFESSOR OR INSTRUCtor to teach fundamental Electrical Engineering courses in Midwest Engineering College. M.S. degree or teaching experience desirable. Position available January 1, 1956 or later. Good salary for qualified person. JAN-1

ASSOCIATE PROFESSOR POSITION AT midwest university. Ph.D. desirable, M.S. essential, with teaching and professional experience in Civil Engineering. Also Instructor or Assistant Professor, with Ph.D. degree or willing to work toward it; will teach principally undergraduate subjects in two subdivisions of Civil Engineering. JAN-2

ENGINEERING FACULTY OPPORTUnities at midwest college. Chairmanship of the Physics Department, salary open. Also opening for Electrical Engineering Instructor or Assistant Professor in Power Field. Mechanical Engineering Instructor or Assistant Professor in Heat Power and Engineering Mechanics. Instructor or Assistant Professor in Physics. Opportunity for graduate study. Housing available. Appointments to begin September, 1956. JAN-3

INDUSTRIAL ENGINEER NEEDED CApable of organizing and teaching Industrial Engineering on the undergraduate level in a regular Mechanical Engineering degree program. Should be active in teaching and professional organizations. Salary and academic rank depending upon degrees and experience. Location, Ohio. Appointment to begin September, 1956. JAN-4

ENGINEERING DRAWING, MECHANIcal Engineering, Engineering Physics positions open for qualified applicants. Salaries commensurate with industrial. Location, Northeastern section of United States. Long established college with highest professional reputation. Please give qualifications with replies. JAN-5

MECHANICAL AND METALLURGICAL Engineering positions available. Rank and salary in terms of education and experience; effective February or September, 1956. M.S. or Ph.D. required. Send resume with application. JAN-6

PROFESSOR OF HEAT POWER OR Fluid Mechanics, interested in assuming department headship; experienced teacher, doctor's degree preferred. Wanted by eastern metropolitan ECPD-accredited college for September, 1956, or sooner if available. JAN-7

HEAD OF OFFICE EXTENSION SERVices in the Institute of Technology, State College of Washington, Pullman, Washington. Rank of Associate Professor or equivalent, salary for eleven months. Appointment effective July 1, 1956. Additional information may be obtained by writing G. A. Riedesel, Secretary, Committee for Industrial Services, 159 Engr. Lab. Bldg., W. S. C., Pullman, Washington.

INSTRUCTOR OR ASSISTANT PROFESsor in Mechanical Engineering. M.S. degree preferred. Teaching will be in the heat-power field, both lecture and laboratory. Rank and salary will be equated with qualifications. Appointment effective September 1 or before. Apply to Prof. J. W. Bunting, Head, Department of Mechanical Engineering, University of Cincinnati, Cincinnati 21, Ohio.

ASSISTANT PROFESSORS AND INstructors in Electrical and Mechanical Engineering wanted by the College of Engineering, Marquette University, Milwaukee 3, Wisconsin. Salary commensurate with qualifications. M.S. or work toward it desirable. Opportunity for part-time graduate work at state university. Please forward complete details of education, experience, and personal background to respective department chairmen.

HEADSHIP OF INDUSTRIAL ENGIneering department. Requires background of professionally responsible management position in industry or government, plus good record of publications. Research and teaching experience desirable. Age range 35–50; salary open; position to be filled before September, 1956. Write Chairman, Nominating Committee, Industrial Engineering Department, Pennsylvania State University, University Park, Pennsylvania.

NEW MEMBERS OF THE ASEE

The fifty-eight listed below join the 217 previously enrolled in 1955, a total of 275 for the year.

ARMSTRONG, GLENN K., Instructor of Petroleum Refining, Colorado School of Mines, Golden, Colorado. William J. Chapitis, George W. LeMaire.

BARNES, KENNETH, Head of Engineering Department, Southern State College, Magnolia, Ark. Geo. F. Branigan, R. G. Paddock.

BARRY, MERTON R., Instructor of Drawing, University of Wisconsin, Madison 5, Wis. R. R. Worsencroft, F. O. Leidel.

BATES, O. KENNETH, Professor of Mathematics and Head of Department, St. Lawrence University, Canton, N. Y. Preston Wood Smith, W. H. Allison.

BELL, JAMES M., Instructor of Civil Engineering, Colorado School of Mines, Golden, Colo. T. A. Kelly, F. E. Smiley, Jr.

BISHOP, ALBERT B., 3RD, Instructor of Industrial Engineering, Ohio State University, Columbus 14, Ohio. Harry D. Moore, William T. Morris.

BORG, MATTHEW F., Instructor in Civil Engineering, Lehigh University, Bethlehem, Pa. Edgar K. Muhlhausen, M. B. McPherson.

BUXTON, OWEN E., JR., Instructor in Mechanical Engineering, Ohio State University, Columbus 10, Ohio. Paul Bucher, S. M. Marco.

CONARD, GEORGE F., Assistant Professor of Metallurgical Engineering, Lehigh University, Bethlehem, Pa. Edgar K. Muhlhausen, Robt. D. Stout.

DAVIS, ALPHEUS G., Assistant Professor of Mathematics, Clarkson College of Technology, Potsdam, N. Y. William B. Conroy, John M. Perry.

FINDLAY, JAMES E., Assistant Professor of Engineering Drawing, University of Notre Dame, Notre Dame, Ind. H. S. Altman, Lee Daniel.

FRIEDLAENDER, FRITZ J., Assistant Professor of Electrical Engineering, Purdue University, Lafayette, Ind. M. M. Boring, E. M. Sabbagh.

GALBRAITH, R. A. HARVEY, Visiting Lecturer in Electrical Engineering, The Rice Institute, Houston, Tex. J. S. Water, L. B. Ryon.

GEORGE, JOHN M., Instructor of English, Colorado School of Mines, Golden, Colo. William J. Chapitis, George W. LeMaire.

GOULARD, ROBERT J., Instructor of Mechanical Engineering, Purdue University, Lafayette, Ind. Raymond Cohen, D. E. Regenbrecht.

HANSON, ARNOLD E., Dean of Academic Administration, University of Toledo, Toledo, Ohio. Edwin D. Harrison, W. Sherman Smith.

HEWSON, E. WENDELL, Professor of Meteorology, University of Michigan, Ann Arbor, Mich. Ernest F. Brater, Victor L. Streeter.

HOTCHKISS, JOHN G., District Engineer and Secretary Committee for Education, American Institute of Steel Construction, Inc., New York 17, N. Y. Robert W. VanHouten, William Hazell.

HRABA, JOHN B., Associate Professor of Electrical Engineering, University of New Hampshire, Durham, New Hampshire. Edward K. Donovan, E. H. Stolworthy.

HOFFEE, HARRY L., Assistant Professor of Electrical Engineering, Ohio University, Athens, Ohio. E. J. Taylor, R. C. Quisenbery.

HUNTERMAN, HENRY JOHN, JR., Instructor of Civil Engineering, Colorado School of Mines, Golden, Colo. L. J. Parkinson, William J. Chapitis.

INGERSOLL, ALFRED C., Assistant Professor of Civil Engineering, California Institute of Technology, Pasadena, Cal. Jack E. McKee, D. E. Hudson.

JENSEN, DEAN ELWOOD, Instructor of Drawing and Descriptive Geometry, University of Wisconsin, Madison, Wis. R. R. Worsencroft, F. O. Leidel.

JURAN, J. M., Consulting Management Engineer, Tuckahoe, N. Y. Norman N. Barish, David B. Porter.

KEIGHTLEY, WILLARD O., Acting Chairman of Civil Engineering, Lawrence Institute of Technology, Detroit, Mich. M. M. Ryan, H. G. Erneman.

KEMPER, ARTHUR B., Head of Chemistry Department, Manhattan College, New York, N. Y. Brother Joseph McCabe, Brother B. Austin Barry.

KING, RENO C., Associate Professor of Mechanical Engineering, New York University, New York, N. Y. Fred Landis, A. H. Church.

KRAJOVIC, JESSE J., Manager College Relations Department, The Glenn L. Martin Company, Baltimore, Maryland. John M. Hollyday, A. Lawrence Guess.

LADD, CHARLES F., Supervisor, Personnel, Industrial Relations Department, American Steel & Wire Division of U. S. Steel Corporation, Rockefeller Building, Cleveland 13, Ohio. Max B. Robinson, Robert B. Auld.

LATHAM, ROBERT F., Instructor of Marine Engineering, U. S. Naval Academy, Annapolis, Maryland. George W. Slaughter, Arthur E. Bock.

LEROY, LESLIE W., Professor and Head of Department of Geology, Colorado School of Mines, Golden, Colo. R. J. Parkinson, William J. Chapitis.

LEWIS, ROBERT M., United States Steel Corporation, Fairless Works, Fairless Hills, Pa. John L. Neal, Jr., Cecil A. Kapp.

LINN, MAX K., Supervisor of Case Costs and Personnel Division, Sandia Corporation, Albuquerque, New Mexico. Thos. Farrell, Jr., J. W. Howe.

MARKS, JAMES A., Instructor of Drawing and Descriptive Geometry, University of Wisconsin, Madison, Wis. R. R. Worsencroft, T. O. Leidel.

MATHIAS, ROBERT A., Assistant Professor of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. Edward R. Schatz, Gaylord N. Penney.

MENIUS, DR. A. C., JR., Professor of Physics and Assistant to Dean of Engineering, North Carolina State College, Raleigh, N. Car. J. Harold Lampe, John W. Cell.

MONSEES, MELFORD E., Chief, Program Development Branch, Supervisory Civil Engineer, Corps of Engineers, Kansas City District, Kansas City, Mo. H. O. Croft, Adrian Pauw.

MORGAN, MOSES J., Assistant Professor and Assistant Agricultural Engineer, State College of Washington, Pullman, Wash. J. Roberts, Max C. Jensen.

MOSS, HARLAND R., Associate Professor of Chemistry, Loyola University of Los Angeles, Los Angeles, Cal. Daniel E. Whelan, Jr., Allen R. Joyce.

OSTLE, BERNARD, Professor of Mathematics, Montana State College, Bozeman, Mont. E. W. Schilling, John W. Hurst.

PIERCE, DONALD FREDEMON, Instructor of Science, General Motors Institute, Flint, Mich. Joseph M. Biedenbach, Paul W. Stout.

PINCKNEY, DALE E., Assistant Professor of Humanities and Social Studies, Montana School of Mines, Butte, Montana. A. E. Adami, W. Clifford Laity.

RENDA, MUAMMER FAIK, Instructor in Mechanical Engineering, Purdue University, Lafayette, Ind. Raymond Cohen, D. E. Hegenbrecht.

RIEGEL, MALCOLM S., Training Coordinator (Personnel), New York Central Railroad, New York, N. Y. G. W. Bergren, O. W. Witzell.

RODGERS, PAUL A., Assistant Professor of Geophysics, Colorado School of Mines, Golden, Colo. T. H. Kuhn, William J. Chapitis.

ROMEO, ALBERT, Instructor of Engineering Drawing, Ohio State University, Columbus, Ohio. Ralph S. Paffenbarger, Chas. D. Cooper.

ROSS, RICHARD A., Instructor of English and Social Science, Franklin Technical Institute, Boston, Mass. Leo R. Dantona, B. K. Thorogood.

SCHIFFMAN, ROBERT L., Assistant Professor of Civil Engineering, Lehigh University, Bethlehem, Pa. Edgar K. Muhlhausen, Cyril D. Jensen.

SMITH, CHARLES O., Staff Member, Oak Ridge School of Reactor Technology, Oak Ridge, Tenn. Donald G. Downing, Albert J. Schwieger.

STRODE, WILLARD, Associate Professor of Architectural Engineering, University of Kansas, Lawrence, Kan. Geo. M. Beal, Donald L. Dean.

THORN, DONALD C., Lecturer, Electrical Engineering, University of Texas, Austin, Tex. R. W. Warner, B. N. Gafford.

TUCKER, WALTER H., Director of Engineering Extension, Alabama Polytechnic Institute, Auburn, Ala. Joshua E. Hannum, Earl D. Brown II.

UNGAR, ERIC E., Instructor of Mechanical Engineering, New York University, New York, N. Y. Austin H. Church, F. H. Posser.

WARD, JAMES B., Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. Henrich J. Oorthuys, Harry W. Hale.

WEBB, BRYAN, JR., Assistant Professor of Electrical Engineering, University of

Arkansas, Fayetteville, Ark. G. Newton H. Barnette, Geo. T. Branigan.

WIERZBICKI, LAWRENCE J., Instructor of Engineering, Loyola University of Los Angeles. Daniel E. Whelan, Jr., John E. Sokoly.

WILCOX, VIRGINIA L., Acting Librarian, Library of Colorado School of Mines, Golden, Colo. L. J. Parkinson, William J. Chapitis.

YOUNG, DONALD F., Instructor of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa. S. J. Chamberlin, Glenn Murphy.

58 new members
217 previously added

275 new members this year

TECHNICAL INSTITUTE BULLETINS

At the November meeting of the ASEE General Council, the need for a list of accredited Technical Institutes and their programs was expressed. It was felt that perhaps college administrators, department heads, and members in general might be unaware of the two publications already available to fill this need, and that additional JOURNAL notice was therefore desirable.

Technical Institute Programs in the United States Accredited by ECPD is issued annually by the Engineers' Council for Professional Development, 29 West 39th Street, New York 18, New York, at 25¢ per copy, about 20 pages. Listed are objectives and procedures for accreditation, accredited programs of the technical institute type (one to three years beyond secondary school), and personnel of regional committees in the technical institute accrediting program.

Our own ASEE Technical Institute Division, in cooperation with the ECPD and the National Council of Technical Schools, has prepared *The Engineering Technician* as a guidance publication. About 16 pages, 25¢ per copy, it can be obtained from the national headquarters, ASEE, Urbana, Illinois. Contents include discussion of the engineering and production team, the engineer, the engineering technician, and the skilled craftsman, educational programs for the engineering technician, and areas of employment.

At the professional level, ECPD also compiles and distributes, at 25¢, *Accredited Curricula Leading to First Degrees in Engineering in the United States and Canada,* as well as its *Annual Report* at $1.00 each. Both are available from ECPD Headquarters.

MEETING OF THE EXECUTIVE BOARD

November 13, 1955

A meeting of the Executive Board of The American Society for Engineering Education was held in Room 116 of Kellogg Center at Michigan State University on November 13, 1955. Those present were: M. M. Boring, President; F. C. Lindvall, L. J. Lassalle, W. T. Alexander, and H. K. Work, Vice Presidents; G. W. Farnham, Treasurer; W. Leighton Collins, Secretary; E. C. McClintock as Editor, and P. N. Powers, guest. President Boring presided.

The minutes of the Executive Board are not printed in complete form to avoid duplicate reporting on actions involving both Executive Board and General Council discussions. Pertinent actions of the Board not referred to in the General Council Minutes are:

1. The Westinghouse Educational Foundation did not approve an expense item of $1,000 for holding a meeting of the Westinghouse Award Committee at which the award winner is to be selected. The Executive Board VOTED not to allocate funds for holding such a meeting and that the committee be so informed.

2. The Executive Board VOTED to approve Hofstra College as an Affiliate institutional member.

3. The Secretary requested each member of the Board to consider adaptation of "Industry's Stake in ASEE" to educational institutions, instead of the previously circulated draft, and submit comments to him.

4. *Division Publications and Division Dues.* The Secretary reported on the increased desire for divisional publications, the increasing difficulties in financing their printing, and the proposal of one division to adopt a $2.00 divisional membership fee. It was agreed that payment of divisional dues could not be a requirement for Society membership nor a requirement for attendance at any meetings of the Society or of any of its Divisions. It was also agreed that divisional or committee publications must not interfere or compete with the JOURNAL OF ENGINEERING EDUCATION. The Executive Board VOTED that the Secretary request all Division Chairmen to send information on divisional publications and their financing to Vice President Lassalle, who would refer a tabulation of the replies to the Publications Committee for recommendations.

5. The Executive Board agreed the Secretary should make a study of the Yearbook Information Card, seeking advice from appropriate sources.

6. The suggestion that a joint committee with the Association of General Contractors be appointed was discussed. It was agreed not to appoint such a committee but that if the Civil Engineering or Relations with Industry Divisions desired liaison they should establish it.

Respectfully submitted,

W. LEIGHTON COLLINS, *Secretary*

MINUTES OF THE GENERAL COUNCIL MEETING

Michigan State University, East Lansing, Michigan

November 14, 1955

A dinner meeting of the General Council of The American Society for Engineering Education was held in the Galaxy Room of Kellogg Center on November 14, 1955, at 6 P.M., President M. M. Boring presiding. Those present were:

George W. Farnham, F. C. Lindvall, James H. Sams, W. T. Alexander, E. T. Donovan, Norman A. Parker, Paul Weber, K. L. Holderman, Ralph A. Morgen, L. F. Eisenberg, P. E. Soneson, Leo. Jos. Lassalle, M. A. Durland, G. F. Branigan, David J. Peery, Donald G. Stillman, W. Irwin Short, M. R. Lohmann, H. K. Justice, Rex Schoonover, C. A. Brown, William Hazell, N. W. Dougherty, L. E. Grinter, W. R. Woolrich, H. K. Work, G. C. Godbey, M. M. Boring, W. L. Collins, A. R. Hellwarth, Harold Flinsch, E. C. McClintock, Mrs. Naomi Garman.

1. *Correction to minutes of June 20 and 22, 1955.* Item 11g, p. 6. The General Council VOTED to substitute the following paragraph, the italicized portions being new:

"C. S. Jones, Chairman of the Division, presented the need for a book *on Technical Institute Education* telling *of the nature* of the work of the Technical Institute and the place of its graduates in industry. *This Division of the Society for some time past has been greatly interested in this and has endorsed the proposal and has officially approved the personnel of the committee as selected.* A. L. Williston wishes to make an initial gift to the Society of securities, valued at $6,000, but to be sold by the Society for defraying expenses involved in preparing *this* book, that the Society administer the funds in a manner similar to that followed for other projects, and that the copyright be in the name of the Society. The Council VOTED to approve the appointment of this Committee, *as a Committee of the Society,* by the President, to accept the securities presented for conversion into cash, and that the Committee be reimbursed for its expenses in accordance with the established practice of the Society."

2. *Report of the Secretary.* The list of subscriptions to the JOURNAL OF ENGINEERING EDUCATION has been studied to improve the bookkeeping and billing procedures. It was agreed that the 150 (approximately one-fourth of the total) which are in an indeterminate status should be discontinued if another letter brings no results.

The Constitution of the Society provides for the dropping of members when they are two years in arrears in dues payments. Prior to being dropped the member must be "notified." The Executive Board authorized the Secretary to interpret the return of first class mail containing the notice of the proposed dropping as "notification."

Preparing the Yearbook has been a tremendous task because of the enormous number of changes. It is hoped errors will be at a minimum but some are bound to creep in. The help of all in informing the Secretary's office of corrections is solicited.

The Executive Board approved a procedure for soliciting funds and a copy will be sent to all Division and Section Chairmen. The procedure also is attached to these minutes as Appendix A.

The yearly dues of the Society for ECPD and EJC memberships have increased; the former from $500 to $600, and the latter from $473 to $945.69. The great increase of the latter results primarily from plans to employ an assistant secretary, additional stenographic help, and rental for more office space. The amount of each assessment is a percentage of the total budget based on the dues income of the Society.

The budgets of Divisions and Committees have been increasing rapidly and now total almost $2000. In the near future these budgets, the problems of divisional publications, and of divisional dues will have to undergo a thorough study.

3. *Report of the Treasurer*

(a) The report for the first quarter of the fiscal year was briefly reviewed. Expenditures were normal. In accordance with the recommendations of the Auditor, this and future quarterly statements will contain only items chargeable to the current fiscal year. However, to enable comparisons to be made with previous statements, the former practice of including all items will be continued (in a separate column) in this year's reports.

(b) $7500. in U. S. Government bonds became due and this amount was deposited in a Boston savings bank in order to earn 3% interest. The savings accounts of the Society will all be placed in Eastern banks which are currently paying 3% interest.

(c) The Annual Audit was briefly discussed. The Society operated at a profit of about $2200 for the year, despite the unanticipated expenses of moving the Society's office from Evanston to Urbana. At the suggestion of the Auditor some changes in the bookkeeping procedures were made. The complete audit was printed on page 397 of the December, 1955, *Journal.*

(d) The Pennsylvania State University has just submitted its final report on the 1955 Annual Meeting and has turned over to the Society a check for $767.88, the excess of receipts over direct expenditures.

4. *Reports of the Vice Presidents*

(a) F. C. Lindvall, regional and sectional affairs. All Sections have now determined the dates for their meetings. A plea was made for closer relationships between the affairs of the Sections and the affairs of other units of the Society, particularly in programming (where the many aspects of the report on Evaluation of Engineering Education must be extensively discussed), in cooperating closely with the Relations with Industry Division in establishing grass-roots programs with industry, in discussing the problem of loss of faculty to industry, and in submitting more papers presented at Section meetings for publication in the *Journal.* At the request of the Physics Division, each Section is requested to appoint a liaison representative to the Physics Division.

(b) L. J. Lassalle, divisional and subject matter affairs. Almost all committees are appointed, a list of the chairmen having been published in the October issue of the *Journal.* A letter is being sent to all Division chairmen presenting suggestions for the Annual Meeting programs and

requesting as many joint meetings as possible.

(c) W. T. Alexander, ECAC. Highlights of ECAC committee work are the completion of the reading list for prospective engineering students, the continued progress on placement tests, and the recognition of the need for increased activity in coordinating the work of secondary schools with the report on Evaluation of Engineering Education.

(d) H. K. Work, ECRC. The Review of Current Research is completed and copies can be purchased for $2.00 each from the ECRC secretary. The book on creativity in engineering needs additional work before it will be acceptable for publication. Plans for the award for outstanding research are progressing and the first award will be made in 1956. The budget of $40,000 for the study of the Research Needs of the Engineering Sciences has been approved by the Executive Board, the plans perfected, and funds from a foundation are being sought.

5. *Report of the Editor.* The Executive Board has authorized the Editor to work with the Publications Committee on changes in the *Journal.* It is intended that in addition to containing high grade papers the *Journal* can be used more extensively to inform members of the activities of the Society, the work of its various units, and the programs of organizations with which it is affiliated. Papers presented at section meetings are the property of the Society and the good papers presented at section meetings should be forwarded to the Editor for publication in the *Journal.* A request for suggestions to improve the *Journal* was made.

6. *Industrial Fellowships Committee.* R. A. Morgen, Chairman, reviewed the proposed program, stating that the committee believed acceptance was desirable because the plan makes available a new source of funds (small companies not able to carry out a program of their own) and because all qualified institutions have an equal chance to receive the fellowships. Copies of a letter from The Leeds and Northrup Foundation stating the proposal (Appendix B) and a copy of "Interim Rules for Industrial Fellowships Administered by The American Society for Engineering Education" (Appendix C) were distributed to all present. The Secretary reported he had consulted the member of the College of Law at the University of Illinois who is an authority on non-profit corporations in the State of Illinois; based on a reading of the objectives of the Society and other pertinent sections of the Constitution that authority was of the opinion that there was no legal problem. The General Council VOTED to approve the plan as presented by the committee except that the number of doctorate degrees granted by an institution between January 1950 and June 1951, inclusive, be three instead of five. In the discussion it was pointed out that this was a "trial run" and that there was no intention of extending the program to include scholarships.

7. *Report of the Committee on Degree Designations.* J. H. Sams, Chairman, presented the statistics obtained by the committee, on which the committee report (first presented at the June 1955 meeting and attached as Appendix D) was based. After considerable discussion, the General Council VOTED to approve the report and request the committee to

continue its study of the five-year first degree and two-year undergraduate programs.

8. *Study of Educational Requirements for Engineers in the Nuclear Industry.* In the absence of P. N. Powers, Chairman of the Atomic Energy Education Committee, the Secretary briefly reviewed the proposal, approved at the June meeting, stating that the budget had been revised. He also reported that at its November 13 meeting the Executive Board voted to approve the budget of $26,100, the money to be raised from industry in the name of the Society and to delegate the responsibility for utilization of the funds to Purdue University provided there is a periodic reporting to the Secretary and providing there is no legal objection to the procedure.

9. *Summer Institute for Engineering Faculty.* In the absence of P. N. Powers, Chairman of the Atomic Energy Education Committee, the Secretary briefly presented the proposal, a copy of which had been mailed to all members of the Council. To facilitate approval of the project, the Executive Board at its November 13 meeting had studied the proposal and voted to recommend to the General Council approval of the plan in principle, as well as the budget of $47,775 provided the General Council accepts the plan. A letter of transmittal dated Nov. 13, 1955 (Appendix E) and excerpts of another letter containing the budget (Appendix F) were read. The General Council VOTED to approve the proposal.

10. *Survey of the Teaching of English in Engineering Schools.* C. A. Brown, representative of the English Division, submitted the proposal, which had been sent to all members of the Council. It was brought out that this study followed logically from the report on Evaluation of Engineering Education and covered an area not included in the Humanistic-Social study. The President stated that the Executive Board had discussed the report at its meeting on Nov. 13 and after considerable discussion voted to recommend to the General Council a deferment of the study until after the final report of the Humanistic-Social Research Project is published and until after the financing of other current projects has been completed. The Executive Board believed the English Division also might wish to consider an evaluation of the engineering student's ability and the relationship of ability (or achievement) to secondary school preparation. The General Council VOTED to defer action on the study, making it very clear the project was not disapproved and could be resubmitted at any future meeting.

11. *Summer School for YETS.* President M. M. Boring explained the changes in the plans for the Summer School. Fifty outstanding YETS selected by their schools are to be employed by industries for the summer, but would be released for four weeks to attend the Summer School. Salary, travel, room and board for those attending the Summer School are to be paid for by the industries; the individual's university is expected to pay the cost of transportation to and from the job location. The Society thus does not need to solicit funds. The estimated cost to industry for 50 YETS attending a four week course is:

Food and lodging	$7,600
Instruction cost	5,000
Service, supplies	600
Stipend to attendees	$25,000
Total	$38,200

The Executive Board reviewed the plan and the budget because of its previous instructions to President Boring to proceed with the development of a program and because the General Council at its meeting on June 20 and 24, 1955 had authorized implementation of the Summer School. The Executive Board voted to recommend the plan to the General Council for approval. The General Council VOTED to approve the plan outlined above.

12. *Summer Institute on Mathematics in Engineering.* F. C. Lindvall, Chairman of the Committee, reported that the closed conference for about 25 will be held at the California Institute of Technology on Nov. 28, 29, and 30, 1955. The open conference will be held at the University of Michigan on June 20, 21, and 22, 1956. The general approach is to determine the mathematical background for engineering as required today, and what it should be for *all aspects* of an engineer's education as it can be envisaged for the future.

13. *Annual Meeting*

(a) The President reported that the Executive Board voted to have two dinner meetings at Iowa State, one on Sunday, June 24, and the other on Wednesday, June 27.

(b) The President reported that the Executive Board recommends the General Council have two meetings at Iowa State, a dinner meeting on Monday, June 25 and a luncheon meeting on Friday, June 29. The latter is a change from a breakfast meeting which has seriously conflicted with the ECAC meeting of institutional representatives; because many members have been expected to attend both meetings, each has been poorly attended. The General Council VOTED that its meetings at Iowa State be a dinner meeting on Monday, June 25, and a luncheon meeting on Friday, June 29.

(c) The Secretary reported that Iowa State has completed its committee organization for the Annual Meeting, that the committee is meeting regularly and sending a copy of its minutes to the President and Secretary, that a preliminary budget has been received, and that Senator B. B. Hickenlooper has accepted the invitation to speak at the Annual Banquet on the subject "Peacetime Uses of Atomic Energy."

(d) The President reported that the 1957 Annual Meeting at Cornell University would be a joint meeting with the American Association of Physics Teachers, provided their Board gives formal approval; that an invitation has been received to have the 1958 Annual Meeting at the University of California at Berkeley; and that the 1959 Annual Meeting would be held at Purdue University on June 22–26. Then General Council VOTED to accept the invitation of the University of California to meet at Berkeley in June, 1958.

14. *Humanistic-Social Research Project.* The President reported that as a result of the request from the Chairman of the project, the Executive Board voted to handle the report in a manner similar to that for the Evaluation of Engineering Education report, to print 10,000 copies, to have the final report submitted to the General Council for approval at its June 1956 meeting, to provide free copies to those attending the Annual Meeting at Iowa State College, and to thereafter sell copies at 25¢ each, 20¢ each in lots of 50 to 100, and 15¢ each in lots of 100 or more, if these prices were consistent with the

cost of printing. There were no objections to this plan, except that it was agreed the report be submitted to the General Council at its meeting on Monday, June 25.

15. *Graduate Study Project.* The President reported the Executive Board approved the budget of $15,000 at its September meeting and that steps were being taken to secure the funds.

16. *Selection, by Sections, of YET sub-chairmen to Serve on the National YET Committee.* The report of last year's YET Committee recommended that instead of the Chairman of the National Committee appointing a sub-chairman for each Section it would be much better for each Section to elect or appoint its sub-chairman, most probably at the time of its meeting. The General Council VOTED that starting with the year 1956–57, each Section select its own YET sub-chairman, informing the Secretary of the selection as soon as possible after July 1 each year.

17. *Difficulty of Employing Teachers to Meet Future Increases in Enrollment.* This common problem was discussed from a number of points of view—employment of retired personnel from universities as well as from industry, responsibilities of industry, use of part-time instructors, and how to get graduates to enter the teaching profession. It was agreed that the questionnaire to be sent out by the Relations With Industry Division to all deans should ask about the availability of retired personnel, their area of teaching, and whether the institution would be willing to employ such people. The compiled replies will be made available to the deans.

18. *List of Technical Institutes and Their Programs.* N. A. Parker presented the need for such information and stated that after much searching the booklets "Technical Institute Programs in the United States Accredited by ECPD" and "The Engineering Technician," published by the Technical Institute Division of ASEE, were the most helpful. It was agreed that these booklets be publicized in the *Journal.*

19. *Joint Committee with the Association of General Contractors of America, Inc.* The General Council agreed with the thinking of the Executive Board that if the Civil Engineering or Relations With Industry Division desired liaison they should establish it.

20. *Aid in Making Movies to Interest High School Students in Engineering and Science.* The Secretary reported a Hollywood studio was planning to make a series of such movies and requested information about the extent of help the Society might give. There was no indication that the Society should participate in such a venture.

21. *Spring Meeting of the Executive Board.* The President announced the Executive Board had voted to have its Spring meeting on April 27, 1956, at the University of Denver; this is the time of the Rocky Mountain Section meeting.

22. *Other Business*

(a) *Report on Meeting of National Commission for UNESCO.* H. K. Justice, who represented ASEE at the November 3–5 meeting of the Commission at Cincinnati, reported that the Commission is an agent of the United Nations and has as its purpose contributions to world peace and security. Much good work has been done in aiding foreign libraries and museums, opening free libraries, de-

veloping a program for arid zones, and establishing a European organization for nuclear research. However, he was unable to determine any way in which ASEE could aid unless UNESCO developed programs of specific interest to the Society or to the International Relations Committee of ECAC.

(b) *Report from Relations With Industry Division.* A. R. Hellwarth, representative of the Relations with Industry Division, reported that the Division is preparing a constitution; that they are interested in and want the help of Sections in stimulating grass-roots interest in RWI activities even though some areas incompatible with section boundaries are desirous of instituting local programs; that a sub-committee with A. R. Hellwarth as chairman would like to make a survey of the colleges of engineering regarding loss of staff to industry and the success of colleges in interesting graduates in teaching careers. The General Council VOTED to approve the making of a survey by the Relations With Industry Division of colleges of engineering to determine the extent of losses of staff to industry and the success of efforts to interest graduates in teaching careers.

(c) *Report of Committee on Follow-Up of the Report on Evaluation of Engineering Education.* President M. M. Boring reported the committee under the chairmanship of W. L. Everitt had met all day and submitted a request for the appointment of a number of committees. The General Council VOTED that the President appoint the following committees:

(1) A committee to study the methods and philosophy of teaching and developing the creative ability in students through work in engineering analysis and design. The purpose of the study will be to define the unique characteristics of engineering analysis and of engineering design and to define the philosophy and techniques of teaching, giving particular attention to their interrelations and methods common to various professional areas as well as the various necessary technological backgrounds.

(2) Six committees, one for each of the engineering sciences listed in the report on Evaluation of Engineering Education, to make a study of the respective areas. The purpose is to define the area, the philosophy of subject development, techniques of teaching (including laboratories), and to recommend a forward-looking plan for each of the sciences involved, giving particular attention to their interrelations and their integration into engineering curricula.

(d) *Fall Meeting.* The President reported that the Executive Board requests the General Council to concur with the decision of the Executive Board to meet with ECPD in October, 1956, the Executive Board having a 6:00 P.M. dinner meeting on Friday, October 26, and the General Council to have a 7:30 A.M. breakfast meeting on Saturday, October 27. The General Council VOTED to concur with the Executive Board action.

The meeting adjourned at 10:30 P.M.

Respectfully submitted,
W. Leighton Collins, *Secretary*

Appendix A—American Society for Engineering Education—Procedure for Securing Funds from Foundations, Industry, and Other Sources

The following procedure shall be followed in all fund raising efforts of the American Society for Engineering Education:

1. All funds are to be raised in the name of the Society.

2. All plans for the raising of funds must be submitted to the Executive Board for their critical examination and approval before any attempt is made to solicit funds; an itemized budget is to be submitted.

3. A member of the Executive Board shall be intimately associated with the presentation of a request or actually do the presenting himself.

4. The accountability for all funds shall be in the hands of the Secretary. This does not preclude the advance of money to program directors or committee chairmen to take care of miscellaneous expenditures for which they will be accountable to the Secretary.

5. The plans submitted to the Executive Board must indicate a continuity of organization and responsibility for the completion of the project by competent individuals.

6. Funds raised are to be adequate to pay for the cost of printing the number of reports deemed adequate to achieve the objectives of the project.

7. The income from the sale of reprints shall revert to the general funds of the Society.

8. Any money remaining after the completion of the project shall be disposed of as directed by the Executive Board.

9. Any departure from these procedures shall have the approval of the Executive Board.

Appendix B—Excerpts from Leeds and Northrup Foundation Letter from I. Melville Stein, Chairman, to W. L. Everitt, ASEE Vice President, June 16, 1955

In recognition of the need for increasing the number of fully trained graduates in engineering and for the support of fundamental research in institutions of higher learning, we desire to support, through the Leeds & Northrup Foundation, graduate study and research in those fields of engineering on which the Leeds & Northrup Company activities are most dependent. Following discussions with you and very helpful suggestions from Dr. Ralph Morgen, I understand that ASEE is willing to undertake the administration of such a program of scholarships and, accordingly, the Leeds & Northrup Foundation desires to commit itself as follows:

We agreed to commit ourselves to the support of a three-year scholarship covering graduate work in engineering leading to a doctorate in engineering, at a total cost of $9000, payable in three annual installments of $3000 each. It is our intention to start such a new scholarship each year, so that by the third year there would be three running concurrently. While this is our intention, it is our feeling that until the support of such graduate study is more fully funded in our Foundation, the program of

starting a new three-year graduate scholarship each year should be an expression of intent rather than a commitment. Accordingly, the present commitment is for a single scholarship at a total cost of $9000, payable as indicated above.

Our present feeling is that these scholarships should be rotated in the fields of electrical, mechanical, and chemical engineering, but not on a rigorous basis because the availability of suitable candidates might make it desirable to depart at times from any systematic rotation in these three disciplines. The selection of both the student and the school would be left entirely in the hands of ASEE.

Appendix C—Interim Rules for Industrial Fellowships Administered by ASEE

I. Purpose

(a) It is recognized that there is need for fellowships to assist graduate students to receive advanced degrees in the various disciplines and to assist the institution in supplying this education to the students. It is further recognized that a considerable number of industrial organizations is aware of this need but that there is a lack of mechanism for distribution of these funds.

It is, therefore, the purpose of this program to make companies aware of the need for research support and the support of graduate students in the various engineering disciplines and to assist the companies in distributing the funds to appropriate institutions in accordance with their wishes.

II. Specific Case

One donation of a grant of $3000 a year for a period of three years has been made to ASEE this year by the Leeds and Northrup Foundation. A copy of the grant document to the Society is attached.

ASEE has decided to accept this generous offer by the Leeds and Northrup Foundation as a test case to explore the possibilities of using this mechanism for the support of further research in the member institutions of ASEE which are eligible in accordance with the donor's request. If this exploratory program proves successful, it is anticipated that additional funds will be sought. In each case, the institution and the graduate student will be aware of the identity of the sponsor. This particular grant will be known as ASEE-Leeds and Northrup Foundation Grant No. 1.

III. Interim Rules for the Academic Year 1955-56

(See "Announcement of ASEE Industrial Fellowships.")

Appendix D—Report of the Committee on Degree Designations

The committee on Degree Designations has considered the resolution of the Technical Institute Division and the further requests from Council and makes the following recommendations:

2 Year and 3 Year Programs—These are Junior College and Technical Institute programs with a minimum of 60 semester hours in two academic years. We recommend the Associate degree in the appropriate field, such

as: Applied Science, Technology, Science, Drafting, or Aircraft Maintenance.

4 Year Baccalaureate and 5 Year Cooperative Programs—These are the most widely offered programs at the present time and lead to a bachelor's degree. We recommend Bachelor of Science in the appropriate field, such as B.S. in C.E.

5 Year First Degree Program—No decision has been reached. It is recommended that this matter be referred to this committee for further study.

Master of Science—A program normally achievable in one year or more above the bachelor's level. We recommend the Master of Science in the appropriate field, such as M.S. in C.E.

Doctoral Program—A program above the master's level requiring additional study and proof of research ability. We recommend the continuance of the present practice of awarding the Ph.D. or Sc.D. for this program. Since the Doctor's degree is often awarded as an honorary degree, it is recommended that some other designation than either of the above be used for honorary purposes and that the abbreviation (Hon.) in parenthesis be shown after such degrees, such as Doctor of Engineering Sciences (Hon.) or Eng'g Sc.D. (Hon.).

Professional Degree—The survey of present practice among engineering colleges shows that the majority of the colleges no longer award this degree. Sixty-one colleges now offer the degree, most of them requiring at least five years of engineering practice after graduation and the submission of a satisfactory thesis. The committee is in favor of discontinuance of this degree as now given.

Respectfully submitted,

S. C. Hollister
K. L. Holderman
Harold P. Rodes
Leo F. Smith
J. F. Downie Smith
H. K. Justice
James H. Sams, *Chairman*

Appendix E—Report to the Executive Board of the ASEE on a Proposed ASEE Institute on Atomic Energy

Late in the summer representatives of Argonne, the AEC, the National Science Foundation, and Northwestern University invited me to consider with the ASEE Committee on Atomic Energy Education possible sponsorship by ASEE of a Nuclear Energy Institute. As a result, the matter was brought before the Committee and examined in detail. It is the unanimous opinion of the Committee that ASEE should sponsor this Institute as a means of helping to alleviate the shortage of engineers with training in the nuclear field.

The specific plan which we have developed is described in the attached materials, including drafts of letters to be sent from ASEE to the National Science Foundation, the Atomic Energy Commission, and Northwestern University.

The details have been worked out by a subcommittee under the chair-

manship of Dean George Hawkins which will, in addition, have the following responsibilities:

1. To advise and assist Dean Loughridge in his administration of the program as may be required.

2. The establishment of a Selection Board with final responsibility for the selection of program participants.

3. To assist in the planning of a curriculum as may be required.

4. To study the need for additional courses in subsequent years as well as for a shorter course for this coming summer for engineering deans and other college administrators.

Submitted by

PHILIP N. POWERS
Chairman, ASEE Committee on Atomic Energy Education

November 13, 1955

Appendix F—The Institute Plan

The purpose of the Institute is to provide engineering college faculty members with training which will help them to incorporate nuclear engineering materials into their courses of instruction. It is proposed that the Institute be held at the Argonne National Laboratory during the summer of 1956 for eight weeks between June 20 and August 25. An outline of the material which should be covered is attached. Enrollment would be limited to sixty participants, and encouragement would be given to groups of two or four faculty members coming from single institutions. It is believed that interchange of ideas among these small groups would increase the carryover from the Institute to the college curricula.

It is further proposed that the Argonne National Laboratory provide this instruction without tuition charge and that stipends along with travel expenses be provided to the participants in sufficient amount to minimize financial hardships to those who attend. The colleges or universities involved would be expected to provide salaries up to $750 with matching stipends and travel expenses to be provided by the National Science Foundation.

Sponsorship of the Institute would be by the ASEE with the National Science Foundation, the Argonne National Laboratory, and Northwestern University serving as co-sponsors.

All administrative matters would be the responsibility of Northwestern University under the policy guidance of the Atomic Energy Education Committee of the ASEE. This would include the administration of the needed funds on behalf of ASEE. Selection of participants would be by a Selection Board to be established by the ASEE Committee. No racial segregation will be practiced.

The budget of expenses which require support by the National Science Foundation is as follows:

Matching funds for the conferees, assuming the average university contribution to be $600.00	$36,000.00
Transportation, calculated to average $150.00 per conferee	9,000.00
Expendable printing, supplies, telephone, accounting and other direct costs to Northwestern University	2,775.00
Total	$47,775.00

ANNOUNCEMENT OF ASEE INDUSTRIAL FELLOWSHIPS

RALPH A. MORGEN

Secretary, ECAC
Director, Purdue Research Foundation
Lafayette, Indiana

For the Committee on Industrial Fellowships

The information given below is published as a matter of record and for the benefit of Society members; it has already been distributed to Deans directly, and the selection of a recipient is well under way.

The American Society for Engineering Education is pleased to announce that it has accepted the generous offer of the Leeds and Northrup Foundation for the establishment of an Industrial Fellowship through the good offices of the Society. The Engineering College Administrative Council of the ASEE has been designated by President Boring to handle the matter for the Society. All communications relative to the Fellowship should be addressed as shown in the heading above.

The specifications of the award, the rules adopted by ASEE for its implementation, and the procedures to be followed are given below:

I. *The Grant*

1. A grant of $3,000 a year for a period of three years has been made to ASEE by the Leeds and Northrup Foundation.

2. The grant is made in recognition of the need for increasing the number of graduates in engineering at the Ph.D. level and for the support of fundamental research at institutions of higher learning.

3. This grant shall be known as ASEE-Leeds and Northrup Grant Number One.

4. It is the present intention of the Leeds and Northrup Foundation to initiate one of these $3,000 three-year grants each year until there will be a total of three such grants in operation at a time.

5. It is a request of the donor that the grants should generally be rotated in the fields of electrical, mechanical, and chemical engineering, but not on a mandatory basis. The availability of suitable candidates may make it desirable to depart at times from any systematic rotation.

6. The selection of both the student and the school shall be the responsibility of the ASEE (See regulations below).

7. The institution receiving the award shall use the funds as follows:

(a) An appropriate stipend to the student, which may be considered a free grant not subject to income tax.

(b) Ordinary tuition to the institution receiving the award.

(c) The balance to be used by the institution as it sees fit to make up the difference between tuition and actual costs of instruction.

8. In the case where the candidate selected has already obtained a master's degree, so that only two addi-

tional years will be required to obtain the doctorate, the ASEE may use the funds for the additional year to support graduate research leading to a master's degree in engineering.

9. In the event that any candidate chosen by ASEE to carry out this program ceases to qualify or be available, the funds made available under the commitment may be used by ASEE in any manner directed in its best judgment toward carrying out the intent of the donation.

II. *Eligibility and Rules for the Academic Year 1956*

1. Eligibility is limited to institutional members of ASEE.

2. The appropriate Deans of Engineering and Deans of the Graduate Schools are advised of the availability of the grant by this notice.

3. In order for an institution to be eligible for this particular award, one or more of its three departments—Mechanical Engineering, Electrical Engineering, or Chemical Engineering—must have granted a minimum of three Ph.D. degrees between January, 1950 and June, 1955, inclusive.

4. The institution must accept or decline the invitation by January 15, 1956, in order to be available for this year's support. A reply is requested as to whether or not the institution is eligible under the rules or wishes to accept the invitation.

5. Accompanying the institution's request to be included in this year's award should be the list of students who have received the Ph.D. degree and their thesis titles in an appropriate area between the indicated dates.

6. The Committee on Industrial Fellowships of ECAC will then select the institution by a random distribution method. Each institution will have one chance regardless of the size of the institution just as long as it meets the minimum requirements of Ph.D. awards. The committee will advise the successful institution of the award by February 15, 1956.

7. The institution will then select an appropriate graduate student, who in its opinion is or can become a candidate for the Ph.D. degree in one of the three areas—Mechanical, Electrical or Chemical Engineering. The award will be made for the fiscal year beginning July 1, 1956. When the student has been selected, his name and qualifications should be sent to the Secretary of ECAC. If the institution originally awarded the grant is unable to select a student before April 1, 1956, it should so advise the secretary of ECAC. The Committee on Industrial Fellowships shall then select, by a random distribution method, another institution; that institution shall then have thirty days in which to select an eligible student.

8. The student and the institution shall retain the Fellowship as long as the student continues to maintain his status at the University, until the Ph.D. degree is awarded or for three years, whichever comes first. The award may not be transferred to another student.

9. Any unused balance from the three-year fellowship shall be retained by ASEE through its Committee on Industrial Fellowships. Rules shall be formulated for distribution of any such balance and shall consider the possibility of awarding one or more Fellowships at the master's degree level in the appropriate disciplines designated by the donor.

FUNCTIONS OF THE ENGINEERING ECONOMY COMMITTEE

ARTHUR LESSER, JR., Chairman

Editor, "The Engineering Economist"

Humphreys Professor of the Economics of Engineering, Stevens Institute of Technology, Hoboken, New Jersey

With the assistance of Anatole Gruehr, Brooklyn Polytechnic Institute, and Norman N. Barish, New York University.
The following statement is published not only for its inherent interest, but also to assist members of the Society in evaluating the request of the Committee for Divisional Status.

Engineering Economy is concerned with decision-making in respect to the economic evaluation of alternative engineering objectives, designs, specifications, and systems (men and machines).

These situations concern themselves with any branch of engineering activity, electrical, mechanical, civil, chemical, industrial, etc., or a combination of two or more branches. Thus, engineering fields supply the technical criteria to the engineering economist: economic factors supply the methods of evaluation; accounting and statistics supply the base data and appropriate techniques.

Engineering Economy aims at optimizing the economic outcome of the project under consideration by the proper choice among alternatives. This involves the best proportioning and most economical use of resources, both material and human, as well as the consideration of anticipated revenues.

As far back as 1925, a Clearing House of Engineering Economy was set up at Stanford University, California, coinciding with the formation of a School of Engineering at that University. This was an informal interchange of papers, examinations, and viewpoints carried on under the direction of J. C. L. Fish of Stanford.

Within the framework of the ASEE (then SPEE) a conference on the Teaching of Engineering Economy was first held in Atlanta in 1935, under the sponsorship of the Industrial and Mechanical Engineering groups of that society. In 1936, a Committee on Engineering Economy was appointed with Eugene L. Grant of Stanford University as Chairman. In May of 1937, a regular page in the JOURNAL OF ENGINEERING EDUCATION was devoted to Engineering Economy, with Edmund D. Ayres as Editor. This page—a more formal continuation of the Clearing House—continued until 1943.

In addition to the activities of the Engineering Economy Committee, the ASEE on three occasions, in 1932, 1936 and 1937,

held summer schools on economics with considerable emphasis on subjects of specific concern to enginering economists.

In 1954 a Summer School for Engineering Economy was held in connection with the annual meeting of the ASEE at the University of Illinois. Papers were delivered by a number of pioneers —Eugene L. Grant, Paul T. Norton, E. Paul De Garmo, Clarence Bullinger. The School also afforded opportunity for presenting the viewpoints of some of the newer men in the field. The program thus assembled speakers who gave papers on three areas. First were the background papers in the areas of Economics, Accounting, and Statistics. Next was a series on Theory and Practice in Engineering Economy and lastly consideration was given to Operations Research and its relationship to Engineering Economy. The Proceedings of the Summer School were published at cost. This publication was purchased by individuals and institutions throughout the nation and is now out of print.

The Summer School summarized the contribution made by Engineering Economy in the past, when the level of empiricism in our technical work was relatively high. It further pointed to the potential role of Engineering Economy in such methodologies as Operations Research and Decision Theory which are evolving as a result of the complexity and growth of industry, the high cost and scarcity of resources—both material and human, and the rapid acceleration of technological change through automation.

Since engineering economy is a discipline applicable to all engineering fields, there is no technical society exclusively devoted to the advancement of theory and practice in engineering economy. The Engineering Economy Committee of the ASEE has provided a medium for the interchange of ideas of those active in the field as well as the development of improved pedagogy. To help implement the work of the Committee, *The Engineering Economist,* to be published quarterly, has been started. The first issue contained an article, "Linear Programming for the Engineering Economist," by Adam Abruzzi. It is the aim of the Committee to seek further challenging papers that would be appropriate for a specialized publication of this type.

ASEE ANNUAL MEETING

June 25–29, 1956

Iowa State College

—— AIM FOR AMES IN 1956 ——

ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

October 19, 1955

To: Members of Engineers' Council for Professional Development 1954–1955 and 1955–1956

Gentlemen:

There is enclosed a resolution adopted unanimously by the members of the 1954–1955 Council present at the Annual Meeting at Toronto, Canada, on October 14, 1955. This resolution recommends that ECPD sponsor a comprehensive survey of the engineering profession and seeks the approval and support of its Constituent Societies.

Accompanying the resolution is a preamble outlining briefly the development of the proposal and a copy of an address by Dean S. C. Hollister before the Annual Meeting which presented the subject for subsequent panel discussion at the meeting.

This information is being circulated promptly to members of Council with copies to the Secretaries of the Constituent Societies, so that the actual facts will be before those concerned. However, it is obvious that a more explicit statement with suggestions for implementation be received by the Constituent Societies before they take formal action, unless the information presented herewith is sufficient to warrant some form of general endorsement and support.

The Executive Committee of ECPD will meet on December 5, and shortly thereafter a more comprehensive statement and suggested program will be transmitted to ECPD and to the Constituent Societies.

It is my hope that the inauguration of a well-considered survey of the engineering profession will stir the imagination and meet with enthusiastic response of the governing boards of our Constituent Societies, and that its consummation will constitute a significant milestone in the history of engineering as a profession and in the esteem in which it is held by the public.

Sincerely yours,

THORNDIKE SAVILLE
President, 1955–1956

RESOLUTION ON SURVEY OF THE ENGINEERING PROFESSION

Adopted at the Twenty-Third Annual Meeting of ECPD on October 14, 1955.

WHEREAS: The Profession of Engineering has ever increasing responsibilities in the rapidly expanding technological aspects of our civilization, and

WHEREAS: these public and professional responsibilities are becoming increasingly complex, and

WHEREAS: the numbers of engineering personnel being trained are both limited in supply and inadequate in numbers to discharge the needs under the present organization of the profession, much less those of the future, and

WHEREAS: the situation confronting the profession is charged with important social, economic, and political aspects in the interest of the public welfare, and

WHEREAS: in the light of these serious public and professional problems a study of the profession is called for, now therefore

LET IT BE RESOLVED: That Engineers' Council for Professional Development sponsor a survey of the Engineering profession to include the present and prospective needs for engineering services, the improvement in the utilization of engineers and supporting technical personnel, the scope and nature of the education and training required, the problems of registration, unionization and ethics involved, and all other matters pertinent to determine the most effective organization of the profession to meet its public responsibilities and professional opportunities, and

BE IT FURTHER RESOLVED: that Engineers' Council for Professional Development seek the concurrence of its Constituent Societies in undertaking such a survey, and

BE IT FURTHER RESOLVED, that Engineers' Council for Professional Development refers this resolution to its Executive Committee for implementation.

NOTES ON ORIGIN OF PROPOSAL FOR SURVEY OF ENGINEERING PROFESSION

WARREN L. McCABE

ECPD Executive Committee

In June, 1954, an informal meeting of engineering deans was called by Dean Hollister at Ithaca, New York. Ten deans accepted the invitation and conducted a two-day discussion at Ithaca on the basic situation and unsolved problems of the engineering profession.

This meeting was stimulated by the work of the American Society for Engineering Education's Committee on Evaluation of Engineering Education. In the course of its activities, the Committee on Evaluation had run head-on into a number of unsolved problems having to do with the profession as a whole. The Ithaca group was also concerned with the fact that although the supply of engineers, as a fraction of the oncoming generation, is a constant and probably has reached its practical maximum, the demand for engineering services based on the total population is increasing exponentially. Not only are important short-range problems involved but a critical long-range problem also emerges from this fact.

The result of the Ithaca meeting was a statement proposed by Dean O'Brien and accepted by the deans' conference on Wednesday, June 23, 1954. A copy of this statement is attached as Appendix 1.

It was agreed that further impetus to this proposal be placed in the hands of Deans T. Saville and S. C. Hollister. On February 23, 1955,

Dean Hollister addressed a communication to Colonel L. F. Grant, President of Engineers' Council for Professional Development. With this letter was forwarded the statement prepared by the ten deans.

On receipt of this communication, Colonel Grant brought the matter to the attention of the Executive Committee of ECPD. At the March meeting of the Executive Committee, Colonel Grant requested Mr. Morris D. Hooven, Vice-President of ECPD (currently President, AIEE) to study carefully the statement of the ten deans and report back with suggestions for possible Council action.

Mr. Hooven reported by means of a letter to Colonel Grant dated July 12, 1955, and presented a short survey of the future composition of the various professional classes important to our national life.

At its meeting of July 28, 1955, the Executive Committee acted and passed Minute 1111, entitled, "The Survey of Engineering Education and Utilization of Engineers." This Minute is attached to this memorandum.

Acting upon the resolution of Minute 1111, two items in the program of the 23rd Annual Meeting of ECPD held on October 13 and 14, 1955, at Toronto, Ont., Canada, were devoted to the problem. The first was an address by Dean Hollister at the luncheon meeting of October 13. The second item was a panel discussion scheduled during the afternoon of Friday, October 14, 1955. This discussion was led by Warren L. McCabe, with the assistance of the following panel: H. N. Meixner, E. I. du Pont de Nemours & Company; M. D. Hooven, Public Service Electric & Gas Company; R. M. Hardy, Dean of Engineering, University of Alberta, Edmonton, Alberta, Canada; Dean Thorndike Saville, New York University; Dean W. L. Everitt, University of Illinois.

At the conclusion of the discussion, which was participated in by many members of the audience, the Council passed a resolution addressed to the Executive Committee, requesting the Executive Committee to proceed with plans for conducting the proposed survey and finding appropriate leadership and financial support for it.

ASEE SUMMER SCHOOLS FOR 1956

Civil Engineering and Construction. Sponsored by the Civil Engineering Division, June 29 to July 1, Iowa State College, Ames, Iowa. Information from Professor C. Martin Duke, University of California, Los Angeles, California.

Engineering Drawing. Sponsored by the Engineering Drawing Division, June 20–24, Iowa State College, Ames, Iowa. Information from Professor W. E. Street, Drawing Department, Agricultural and Mechanical College of Texas, College Station, Texas.

Humanistic-Social. Sponsored by the Humanistic-Social Division, June 28–30, Iowa State College, Ames, Iowa. Information from Dr. Melvin Kranzberg, Social Studies, Case Institute, Cleveland, Ohio.

THE NEED FOR AN APPRAISAL OF THE ENGINEERING PROFESSION

S. C. HOLLISTER

Dean, College of Engineering
Cornell University
Ithaca, New York

An address presented at the Twenty-Third Annual Meeting of ECPD
Toronto, Canada, October 13, 1955

There is no doubt that during the past quarter century the tempo of the whole world has increased to an astonishing degree. Through developments in engineering, our communications and transportation systems have created the illusion that the world is shrinking so that it is now practically only a fraction of the size it used to be. Because of this tremendous change in communications and transportation, the world political arena has been completely altered. Mass attitudes are being built up or broken down.

The engineer is at the core of this development. His group has created many of the technical means which have brought about this change and in many instances has participated in the direction of its development. To an increasing degree he is becoming a practicing sociologist, an active economist, a political planner, all in addition to his functioning as one who interprets scientific principles into useful works.

While human and international relationships have been shifting at a remarkable rate—a shift in which the engineer's work has been an active ingredient—the very basis of his technical accomplishments, namely, the fund of scientific knowledge, also has been enormously expanded in this period of time. One can only partially dream of the tremendous ramifications of this new knowledge and the extent to which it may be applied to human service.

The public has become aware of the many accomplishments of the engineering profession having a bearing on our daily life—accomplishments that bring men closer together, that unify their problems and common concerns, that lighten their burdens and extend their capacities, and that enhance the common welfare.

Engineers have accomplished so much that now it is taken for granted that what they produce will function without difficulty. It is further taken for granted that they will safeguard the life and property of the public. Nobody stops at the end of a bridge to make computations to see whether or not he should cross the bridge. There is still another public assumption that puts a tremendous responsibility upon the engineer. He has worked so many miracles in the eyes of the public that it is now assumed that he will bail mankind out of any crisis that may arise. Take for example our present headlong dash toward consuming our natural resources. If the question is raised that perhaps we should be more cautious we are told at once that when the pinch comes

they will find something else that probably will be better. "They" in this case means the engineer.

It is easy to see, therefore, that the engineer has assumed in the mind of the community a professional status. As a group, engineers have become a definite entity both as to function and accomplishment in the public mind. This is true regardless of whom the engineer works for or what are the arrangements of his employment.

The services engineers are being called upon to render are increasing not uniformly with time, but exponentially. We know that there are many things on the shelf waiting to be worked upon. We know that new knowledge, useful for the engineer, has been increasing at a tremendous rate. We know also that even with the normal development of former lines of engineering, new avenues of approach are opening in many directions. Thus, not only as time goes on, but also with the increase in population, the services engineers need to render are increasing at a faster and faster rate.

There is much evidence to show that only a certain proportion of our population has the necessary qualifications to undertake the engineering profession. Many of those qualifications are similar to those required for success in other lines. Out of a given age group, that is, for example, out of the number of boys reaching age eighteen in a given year, only about seventeen per cent have the necessary intellectual capacity to undertake work in our profession. This same seventeen per cent, however, must also supply the talent for other professions, as law, medicine, science. They must also supply the top-level people in the crafts, including the better chefs, cabinet makers, glass-blowers, tool makers, and the like. The interplay of interests, the degree of enterprise or of fortitude, will have a bearing upon which field the boy enters for study.

Several years ago I was able to point out that only about 47,000, amounting to one-fourth of the seventeen per cent I mentioned, could be expected to enter the engineering profession at the freshman level. We have, through the beating of drums and the shaking of bushes, gone higher than this number. A study of performance in college, however, points out that it is quite apparent that after we passed approximately 47,000 the mortality rate took a sharp increase. In other words, it would seem we are dipping a little further into the supply and reaching a little below the likely level of capacities.

In speaking of this matter of intelligence, the capacity for receiving a particular kind of education, it must be borne in mind that we are doing so in the light of our educational methods, our guidance systems, and the manner in which we communicate to the oncoming youth the possibilities and attractiveness of the various professions and other occupations which he might conceivably be capable of entering. We need to make improvements in all of these methods of communicating with the youth and we need improvement all along the line in educational operations. These, however, are not going to be changed suddenly. It will be a long process of evolution if we are to make any changes, but we must continually try.

Returning now to the meaning of our experience of the success and failure of boys attracted to the engineering profession, it is apparent that we

have reached a fixed percentage of the population that will enter engineering. When we look again at the services that engineers are being called upon to perform and the fact that these service needs are increasing at an accelerating rate, we see that the demand for services is outrunning the rate of supply of people to perform them. This does not necessarily mean that we have to go without such services, at least not for the present.

It does mean, though, that the pattern of utilization of engineers must be modified considerably. We know that in many fields the beginning engineer soon progresses to paper work and from there to administrative duties and frequently to less and less engineering contribution. The pattern of advancement is often in lines other than engineering. It is necessary to modify this state of affairs so that the path and the rewards lie closer to engineering practice. In this respect we can take a leaf out of the book of the medical profession where the number of doctors is about half the number of engineers.

Any clinical doctor performs as the nucleus of competent but less trained people and in such a way the ability of the doctor is proliferated over a wider contact area. To some degree the legal profession is organized along similar lines. The engineering profession, if it is to render the services that we know are ahead of it, must be considerably overhauled both in the manner of utilization and in the pattern of preparation for such a career.

There are already signs of threats to the profession that should motivate us to prepare soon for a re-evaluation of our professional activities. On the one hand, scientists are entering the field, in many cases with telling effect. They have better fundamental training and for the most part they are able to stay in the professional field without shift to administrative function. At the other end of professional activity we are feeling the effects of unionization in areas where large numbers of young engineers may be used in more or less standardized and routine functions. We have become, in a part of the profession at least, slaves to job classification rather than men working toward the utilization of individual talents in their highest form.

In the foregoing remarks I have simply presented my personal impressions of the situation in the profession. Most of them are qualitative. Many of them are in some degree controversial. What is lacking in this critical situation is an accurate, carefully made appraisal of both utilization and supply.

Suppose, for example, we have a scientific sampling of each school of engineering and we followed the progress of each graduate in the sample. If we did this for different classes of graduates we would amass a body of material that would give us a consolidated picture of the training, development, growth, utilization, and accomplishment of the individuals in the profession. We would then be able to note with some assurance the factors to which we could most profitably give attention.

It is clear, or so it seems to me, that the profession is badly in need of a comprehensive survey having as its objective the evaluation and appraisal of its present and likely future adequacy, and an appraisal of the areas in which action must be taken to effect indicated improvements.

This Council asked in 1952 for an appraisal of the preparation of engineers and referred the matter to the American Society for Engineering Education. That Society has completed such a study and during the current year has published its report. It is a useful and important study and if implemented will, I am sure, contribute to the progress of the profession. But at the same time one is impressed with the fact that it deals with but one facet of a very much larger problem, a problem that the educators may see but can do nothing about.

A notable study was made of the medical profession about forty years ago which culminated in the famous Flexner Report. This report has had a profound effect upon the development of the medical profession and has strengthened the effectiveness of that profession in its services to the community. In consequence it has contributed greatly to the stature of the medical profession in the eyes of the community.

More recently, a similar study has been undertaken in the legal profession. It is too early to mark the results but undoubtedly similar benefits will derive from it.

It would seem clear that everybody stands to gain by a well-executed study of this sort. First of all the community would be served by any improvement that could be brought about in the functioning of our important profession. Those immediately concerned with function, namely, the employers of engineers and the engineers themselves, would profit both individually and collectively by such a well-designed and well-executed survey. And finally, such a survey should lay the groundwork for improvement and better definition of the engineering profession as a whole.

Who should sponsor such an undertaking as this? It has been suggested that each of the professional branches should undertake a study of its own. One only needs to recall the interweaving of the services of the separate branches, the extent to which they have a relatively common background, the fact that in many cases their talents and efforts impinge upon the same general problem, and the fact that many, trained in one branch, actually serve through their professional lives in another branch, to realize that there would be duplication, waste of effort, waste of money, and in general unnecessary confusion if the study were to be made in that manner. Furthermore, it seems to me that such a study needs background that can be obtained only through the guidance of an organization whose principal objective is the development of the engineering profession in all aspects. Clearly then, the sponsor for such an operation should be the Engineers' Council for Professional Development.

What is needed to accomplish such a survey? It would seem appropriate to set up an advisory board from the engineering profession to give guidance to the inquiry itself. This board should represent the various branches of engineering. It should represent different elements of the structure of the profession and different ways in which these elements function. It should be as small and compact as possible. It should report to this Council.

Under such a board should be organized a competent full-time staff to conduct the survey. It should be headed by a full-time director. It

should be staffed with specialists appropriate to the different lines of inquiry.

It would be essential that the operation be adequately financed since it is conceivable that the cost of such a survey would in the end amount to as much as a million dollars. There seems no question, however, that the benefits to be derived by the community are so great that such a sum becomes unimportant in proportion to the benefits.

As I view our profession and with quiet pride appraise its accomplishments, I feel at the same time a sense of the heavy responsibility that is placed upon us to discharge the enormous volume and range of function that we face. As I look ahead it seems to me that this range and volume grows to staggering proportions and must develop within us all a great sense of urgency to perfect the structure of our profession so that it may continue in its great tradition. I see no greater service that this Council can perform, either to the profession or to the community, than to bring into being such an organization, designed for the appraisal and for the guidance and further development of our profession. I believe that both for the profession and for the community we have arrived at a stage where time is now of the essence.

SOVIET SECONDARY EDUCATION

An article on "Soviet Secondary Education—designed to achieve future scientific supremecy," by Eleanor S. Lowman, specialist in Soviet Education in the International Education Division, U. S. Office of Education, in the December, 1955, issue of *Higher Education* presents an interesting contrast with American public and private preparatory school practices. Commenting on the utilitarian nature of the Russian program, which is placing increased emphasis on scientific and technical training, expanding the rate of high school-equivalent graduations, and orienting the secondary curriculum to one of greater value for sub-profession technicians and laborers, sharp differences are pointed out between humanistic and technical curricula in the U. S. and in Russia.

Each of the more than one million students graduating from Russian secondary schools last June, said the article, had taken five years of physics, one year of astronomy, four years of chemistry, five of biology, and ten of mathematics, including algebra, geometry, and trigonometry. At the same time, the USSR has been directing teacher training into scientific areas so that there will be no shortage of secondary school instructors. The Soviets are building large secondary schools and universities, and have raised their entrance requirements. All this is apparently directed, however, not only to preparation for professional work, but increasingly toward filling the manpower shortages at practical and sub-professional levels.

Young Engineering Teachers' Paper Contest

RULES

Eligibility: Members of ASEE who are not over 35 years of age (their 36th birthday must not be before June 1, 1956).

Awards: First prize $200—Second prize $100.
Honorable mentions as determined by the Judging Committee.

Presentation of Awards: The awards are known as the "President's Awards." They will be presented to the recipients by the President of the Society at the Annual Banquet at Iowa State College, June 28, 1956.

Subject: Papers should deal with some constructive phase of improvement of engineering education. Participants are encouraged to use their own judgment in selecting appropriate subject matter.

The following are suggestions of possible subjects:

1. Professional development of the Young Engineering Teacher.
2. How should the student be helped to learn to deal with situations that are new to him, on his own initiative and with well-ordered professional thinking?
3. To what extent should modern physics be included in the engineering curriculum and how should this be done?
4. What areas of physics, chemistry, mathematics and biology not now taught in engineering curricula are likely to be translated into significant engineering practice in the next 15 years and how should this influence present curricula?
5. To what extent and in what manner should undergraduate instruction acquaint the engineering student with the methods of research and with recent research developments in engineering and closely allied sciences?
6. What should be taught of the art of engineering as contrasted with its science?
7. What basic science, mathematics and communication principles and skills can best be taught by separate department staffs and what part by integration into engineering courses?
8. What can be done in college to prepare the young engineer to continue to learn after his formal education is ended?
9. How should non-major courses in engineering such as electrical engineering for non-electricals be planned as to content and method?

Length of Paper: Not to exceed 2500 words.

Submission of Entries: All entries should be submitted to the Chairman of the ASEE Section in which the member resides before March 1, 1956. Names and school affiliations of Section Chairmen are published each month on the page in the Journal of Engineering Education designated "Section Meetings." Papers submitted in the contest last year or in other contests are not eligible for this year's contest.

Judging: Each Section of ASEE will appoint a Judging Committee to select the best paper from the Section. This paper will be submitted to the ASEE Secretary before April 1, 1956.

The winning papers from the various ASEE Sections will be submitted to a Final Judging Committee for the final selection.

Here is an opportunity to gain national distinction. Good luck!

Members have requested that the application blank be reproduced more often, so that it could be available for potential new members. Accordingly, it is printed below.

APPLICATION FOR MEMBERSHIP

Date .....

I desire to become a member of the American Society for Engineering Education and hereby agree to conform to the requirements of membership, if elected, and submit the following statement of qualifications:

Name .....
Print last name First Middle

Mailing address .....

City and State .....

Full title of
professional position .....
Title Department

Institution ..... Date of Birth .....

Degrees and names of institutions granting .....

Sponsors .....

.....

To be signed by two sponsors, members of ASEE, and returned to
W. L. Collins, Secretary, ASEE, University of Illinois,
Urbana, Ill.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NOMINATION BLANK

"ARTICLE XI, Section 3. (Election of Officers) By means of a form to be printed in The Journal of Engineering Education or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee."

In order to make the election of officers of the Society as democratic as possible, members are urged to fill out the nomination form and return before April 1, 1956 to the Secretary, W. Leighton Collins, University of Illinois, Urbana, Illinois.

I nominate the following members of the Society for officers:

For President .....

.....

For Vice-President .....
(*In Charge of Instructional Division Activities—two years*)

.....

For Treasurer .....

.....

Signed .....

Title .....

Institution .....

Date .....

SECTION MEETINGS

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny	Carnegie Institute of Technology	April 27–28, 1956	J. W. Graham, Jr., Carnegie Institute of Technology
Illinois-Indiana	Purdue University	May 12, 1956	O. W. Witzell, Purdue University
Kansas-Nebraska	University of Wichita	Oct. 26–27, 1956	J. K. Ludwickson, University of Nebraska
Michigan	Wayne University	May 5, 1956	G. H. Howell, Wayne University
Middle Atlantic	Bell Telephone Laboratories, Murray Hill, N. J.	May 12, 1956	C. C. Carr, Pratt Institute
Missouri-Arkansas	St. Louis University	April 7, 1956	J. B. Macelwane, St. Louis University
National Capital Area	Capital Radio Engineering Institute, Wash., D. C.	Oct. 11, 1955	D. C. Jackson, Jr., Aberdeen Proving Ground
New England	University of Maine	Oct. 19–20, 1956	W. S. Davis, University of Maine
North Midwest	South Dakota State College	Oct., 1956	J. W. Howe, State University of Iowa
Ohio	Ohio State University	April 27–28, 1956	E. C. Clark, Ohio State University
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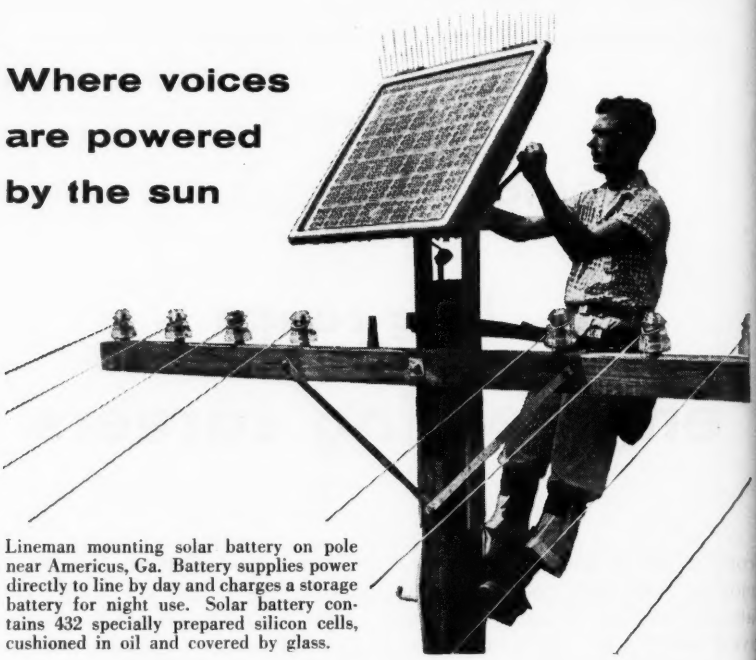

Lineman mounting solar battery on pole near Americus, Ga. Battery supplies power directly to line by day and charges a storage battery for night use. Solar battery contains 432 specially prepared silicon cells, cushioned in oil and covered by glass.

A new kind of telephone system developed by Bell Telephone Laboratories for rural areas is being operated experimentally by electric current derived from sunlight. Electric current is generated as sunlight falls on the Bell Solar Battery, which a lineman is seen adjusting in position.

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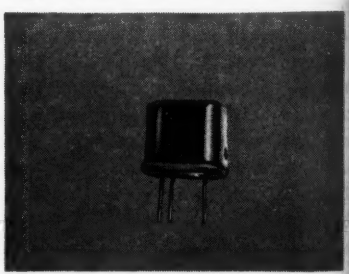

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